MANEJO DE SERVICIOS ECOSISTÉMICOS EN BOSQUES TROPICALES

COMUNICANDO CIENCIA A TOMADORES DE DECISIÓN

Polinizadores y servicios ecosistémicos

Seminário de Desarrollo Profesional sobre Gestión de Servicios Ecosistémicos de Bosques Tropicales

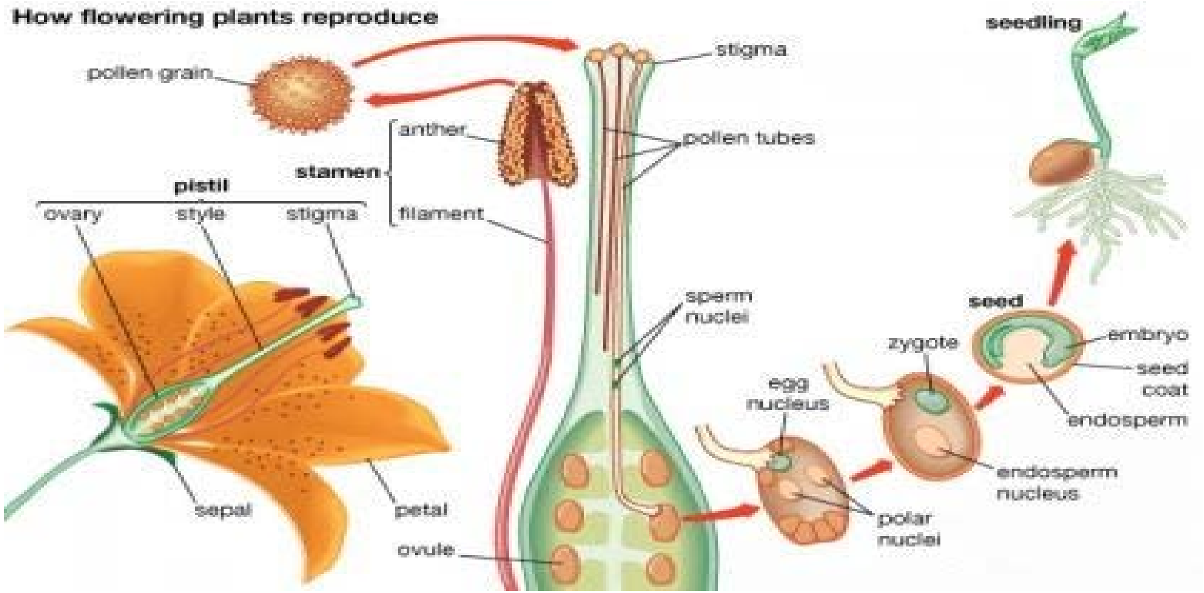
25 - 29 de julio 2016 – Liberia, Costa Rica

Sección 1: Introducción

Que es polinización?

La deposición de polen viable de las anteras (la parte masculina de la flor) en estigmas (la parte femenina) compatibles y receptivos…

…resultando en la producción de frutos y semillas.



www.science-online.com

Quien son los polinizadores?

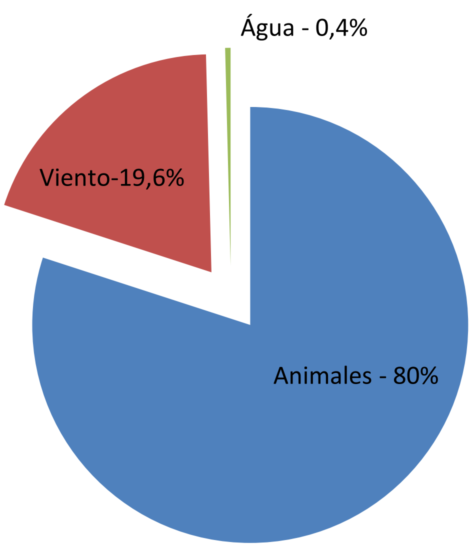
Abióticos

Lodgepole pine (*Pinus contorta*)

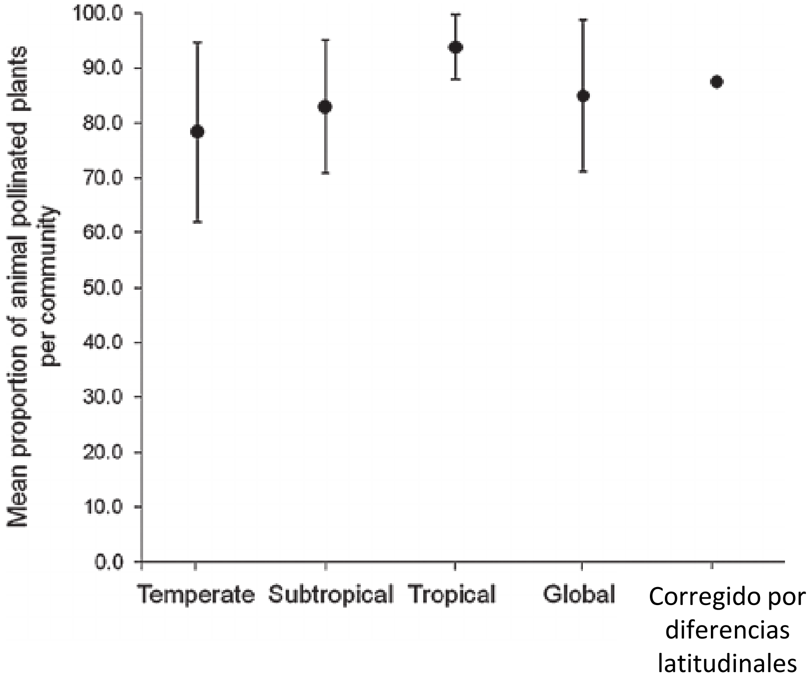
Vallisneria americana

Quien son los polinizadores?

Quien son los polinizadores?



http://www.cichlid-forum.com/articles/anubias_great_plants_pt3.php



Ollerton et al. 2011

Cuales son los servicios que prestan?

Alimento

Cuales son los servicios que prestan?

Biocombustibles

Fibras

Medicamentos

Cuales son los servicios que prestan?

http://potnia.theladyofthelabyrinth.com/symbols-of-the-minoan-goddess-religion/

Artes y las artesanías

https://www.theguardian.com/commentisfree/2015/jun/17/why-are-bees-important

Inspiración para el arte, la música, la literatura, la religión, las tradiciones, tecnología y educación

Sección 2: Estado actual de los polinizadores

Evidencias de impactos en polinizadores

Cambios en abundancia y riqueza

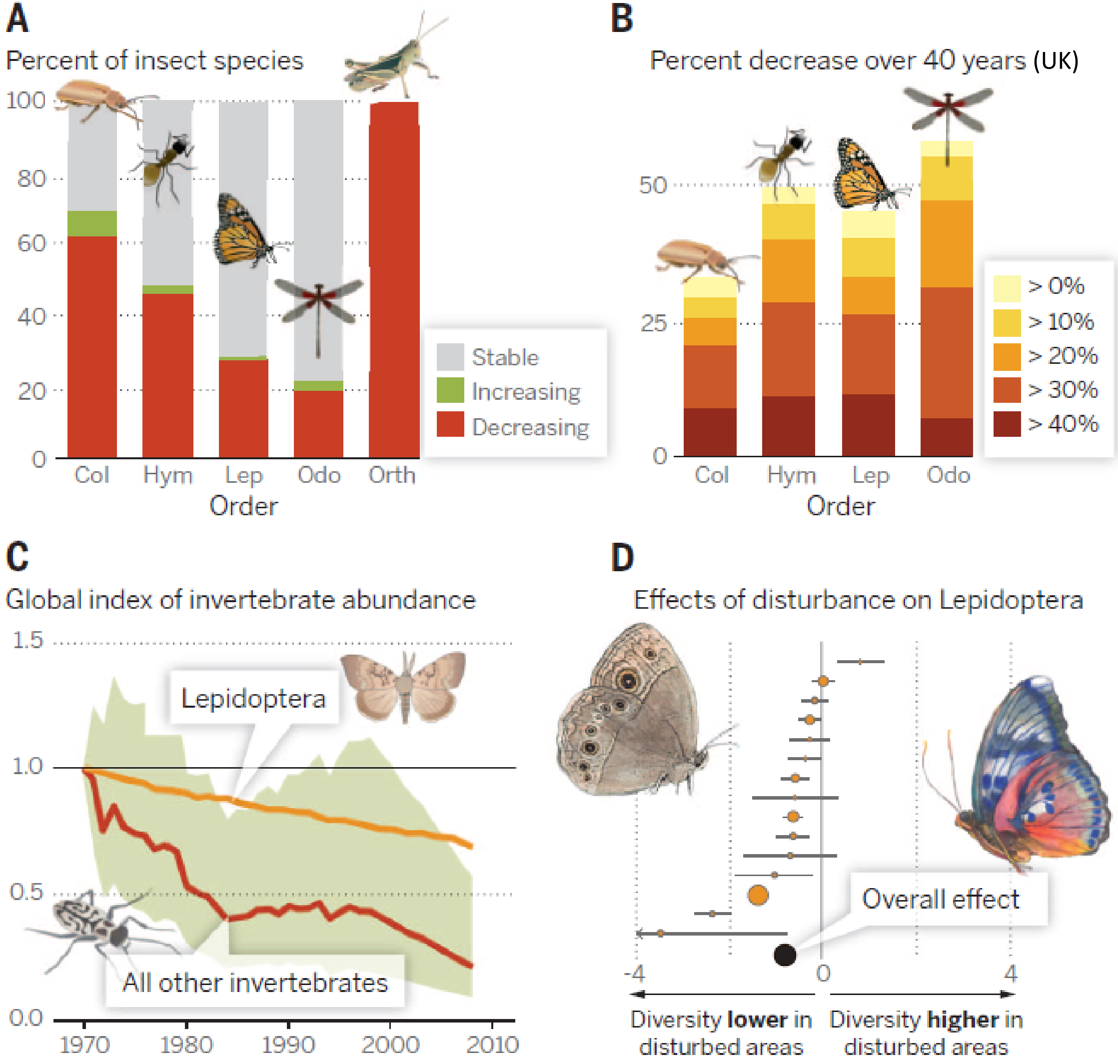
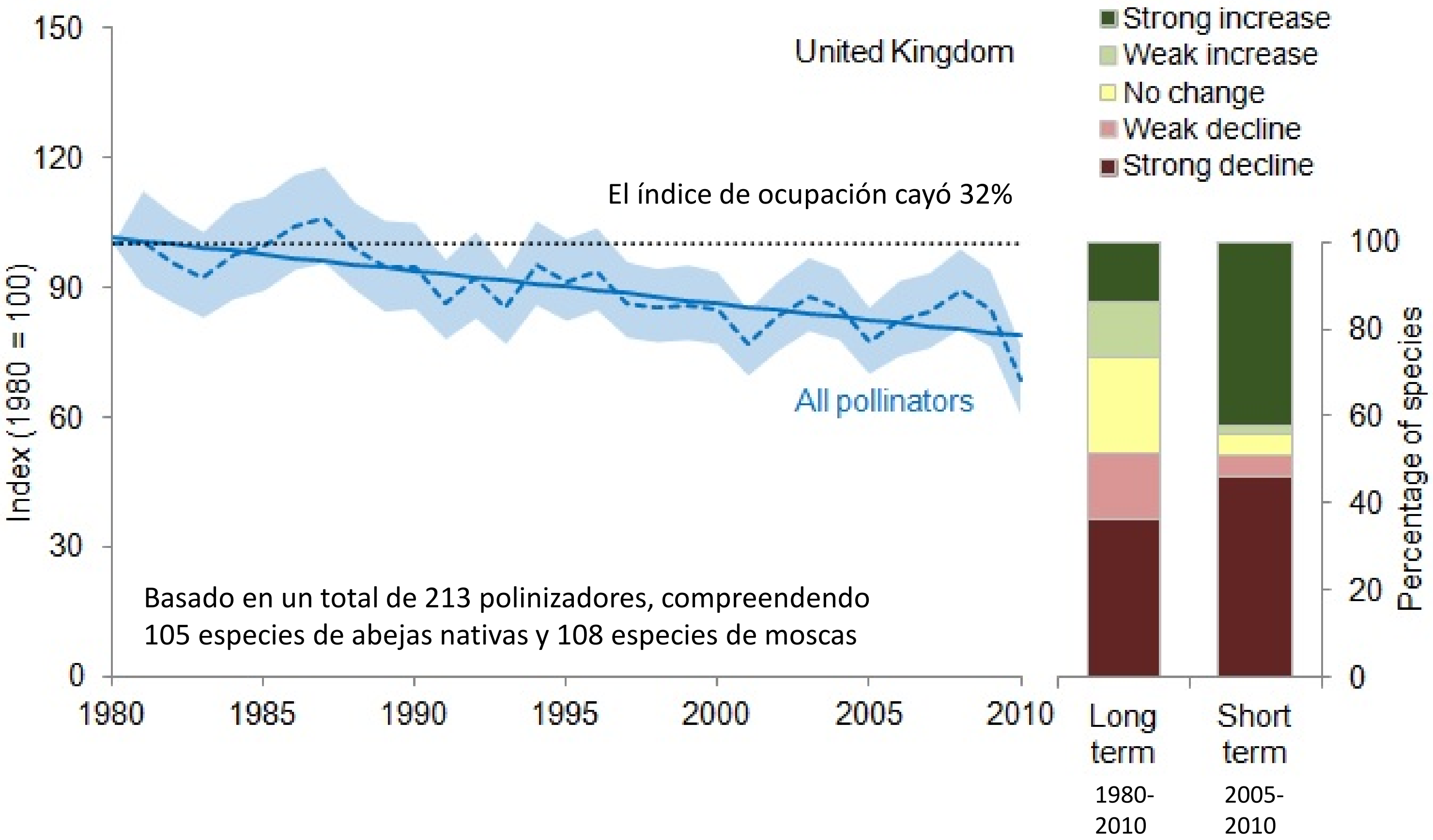


Fig. 1. Evidence of declines in invertebrate abundance. (**A**) Of all insects with IUCN-documented population trends, 33% are declining, with strong variation among orders (*19*). (**B**) Trends among UK insects (with colors indicating percent decrease over 40 years) show 30 to 60% of species per order have declining ranges (*19*). (**C**) Globally, a compiled index of all invertebrate population declines over the past 40 years shows an overall 45% decline, although decline for Lepidoptera is less severe than for other taxa (*19*). (**D**) A meta-analysis of effects of anthropogenic disturbance on Lepidoptera, the best-studied invertebrate taxon, shows considerable overall declines in diversity (*19*).

Dirzo et al. 2014

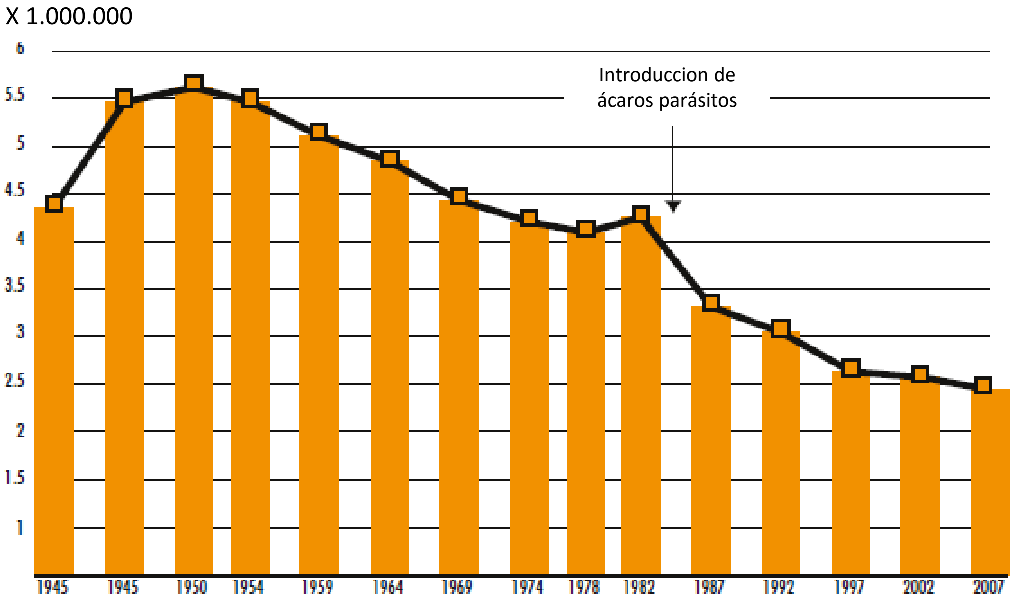
Cambios en distribución geográfica



Source: Bees, Wasps & Ants Recording Society; Hoverfly Recording Scheme; Biological Records Centre (supported by Centre for Ecology & Hydrology and Joint Nature Conservation Committee). http://jncc.defra.gov.uk/page-6851

Cambios en abundancia

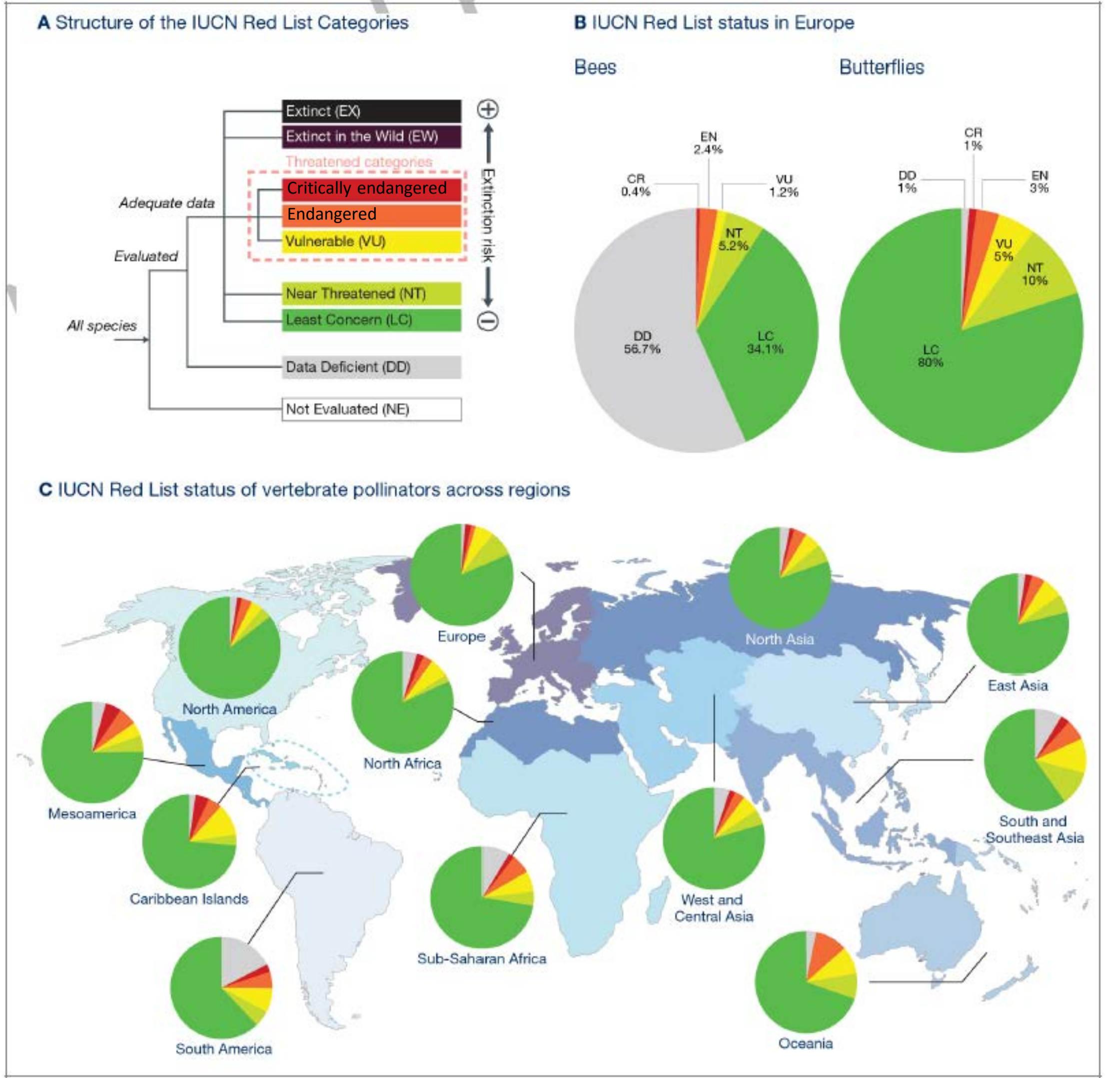
Colmenas de producción de miel en Estados Unidos



Data source: U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) NB: Data collected for producers with 5 or more colonies. Honey producing colonies are the maximum number of colonies from which honey was taken during the year. It is possible to take honey from colonies which did not survive the entire year.

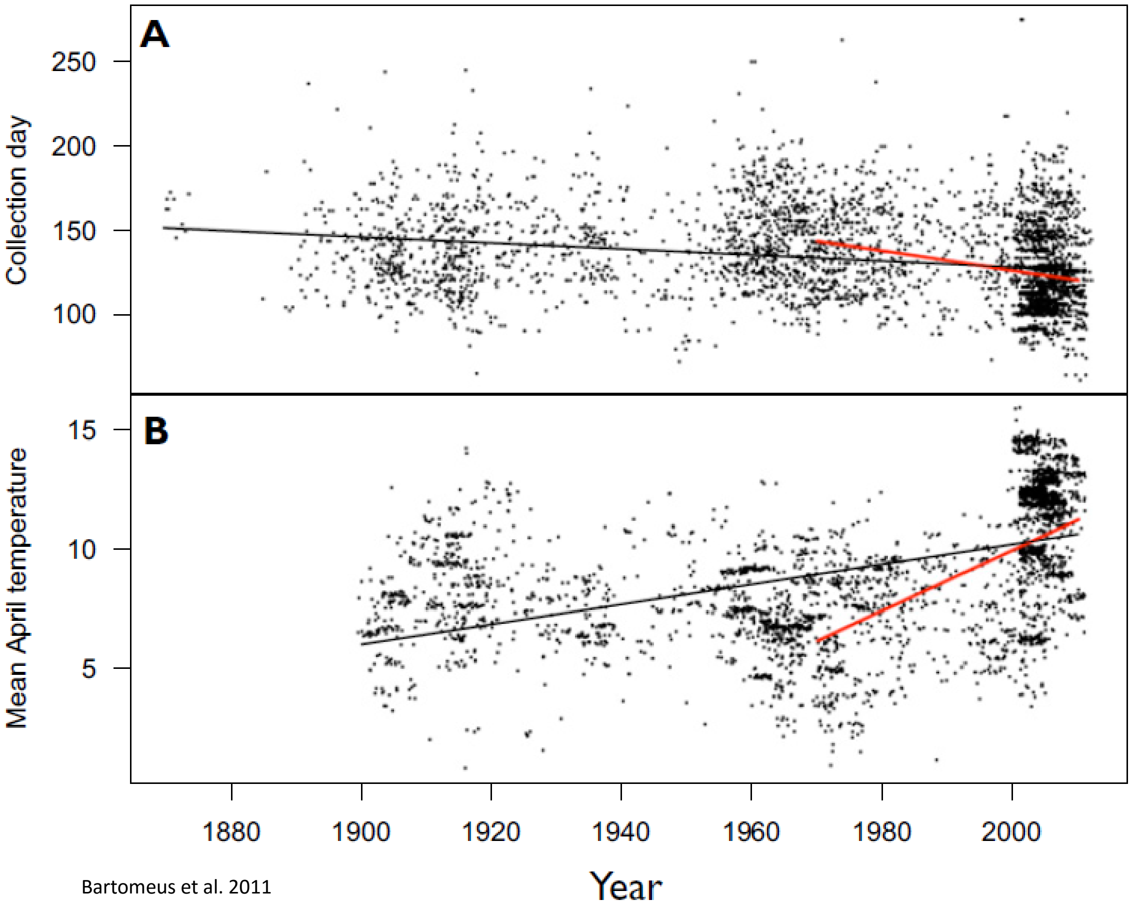
Riesgo de extinción

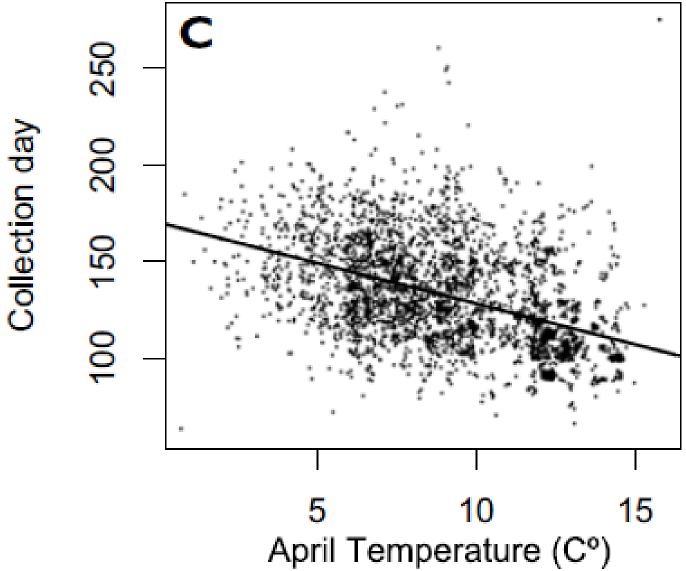
2.4 especies deterioran en su posición a cada año



IPBES 2016

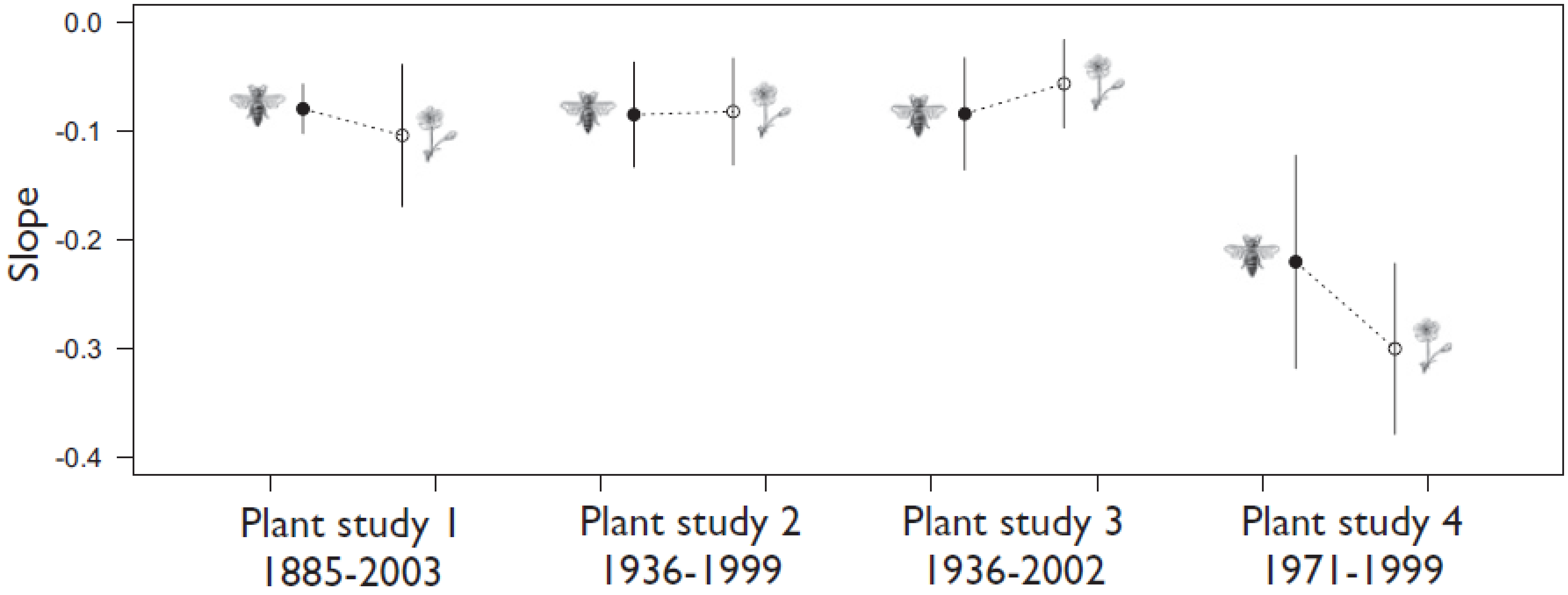
Cambios en fenologia



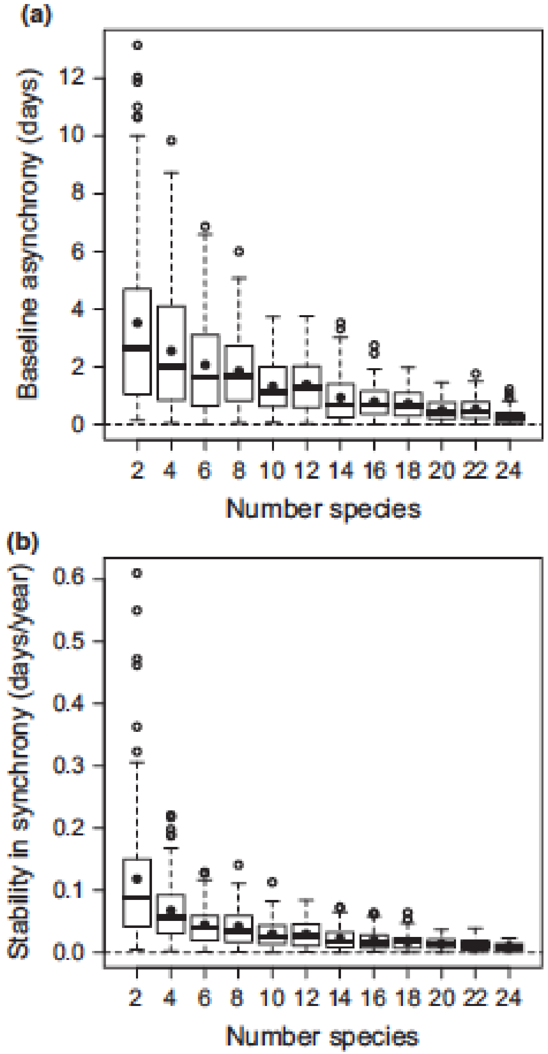


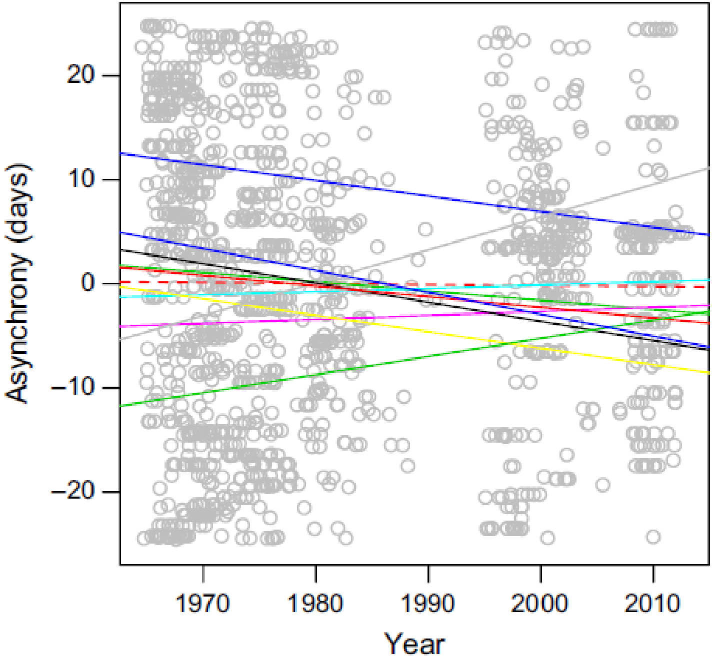
Bartomeus et al. 2011

Cambios en fenologia



Cambios en fenologia

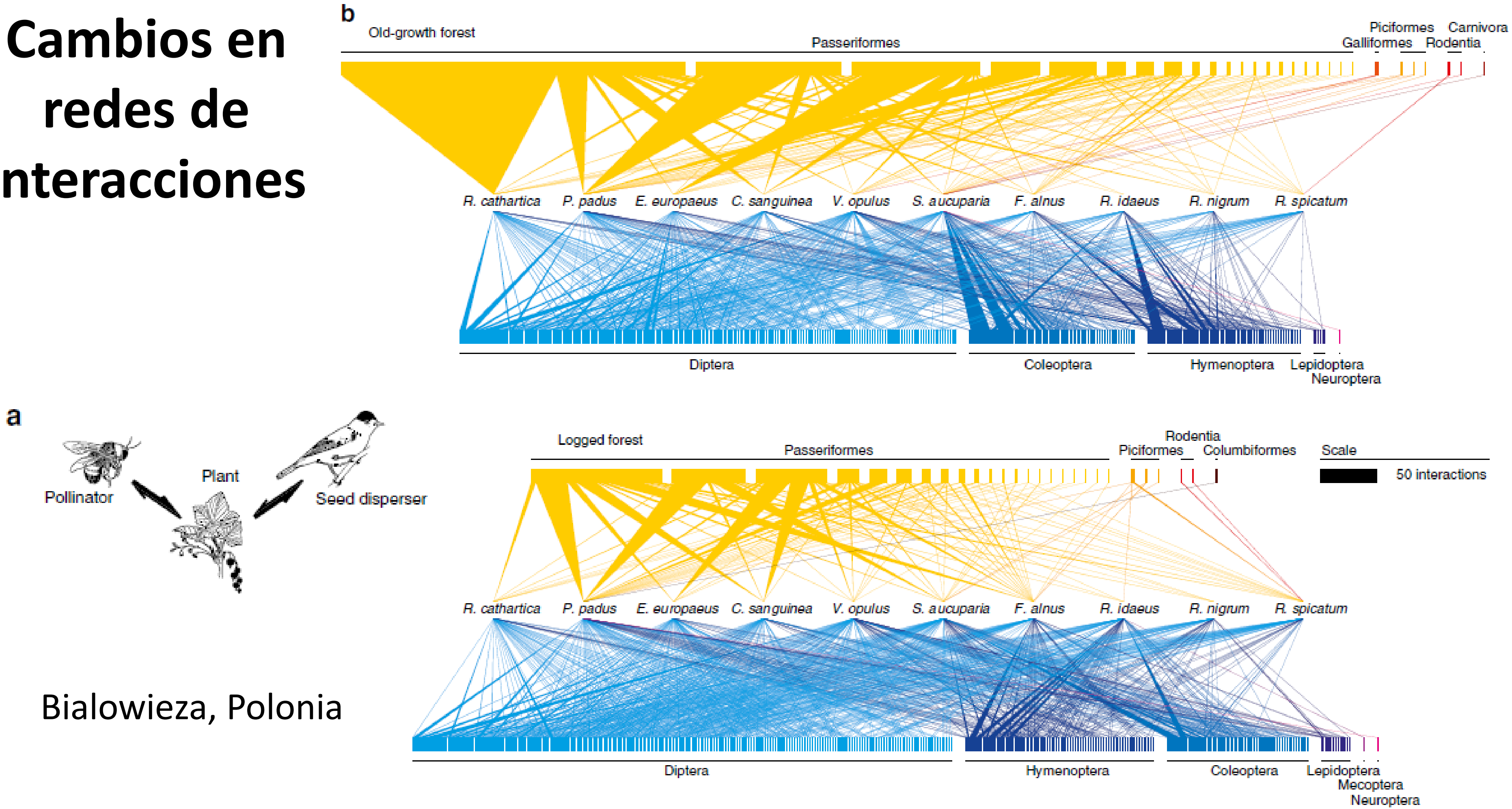




La importancia de la diversidad de polinizadores

Bartomeus et al. 2013

Cambios en redes de interacciones

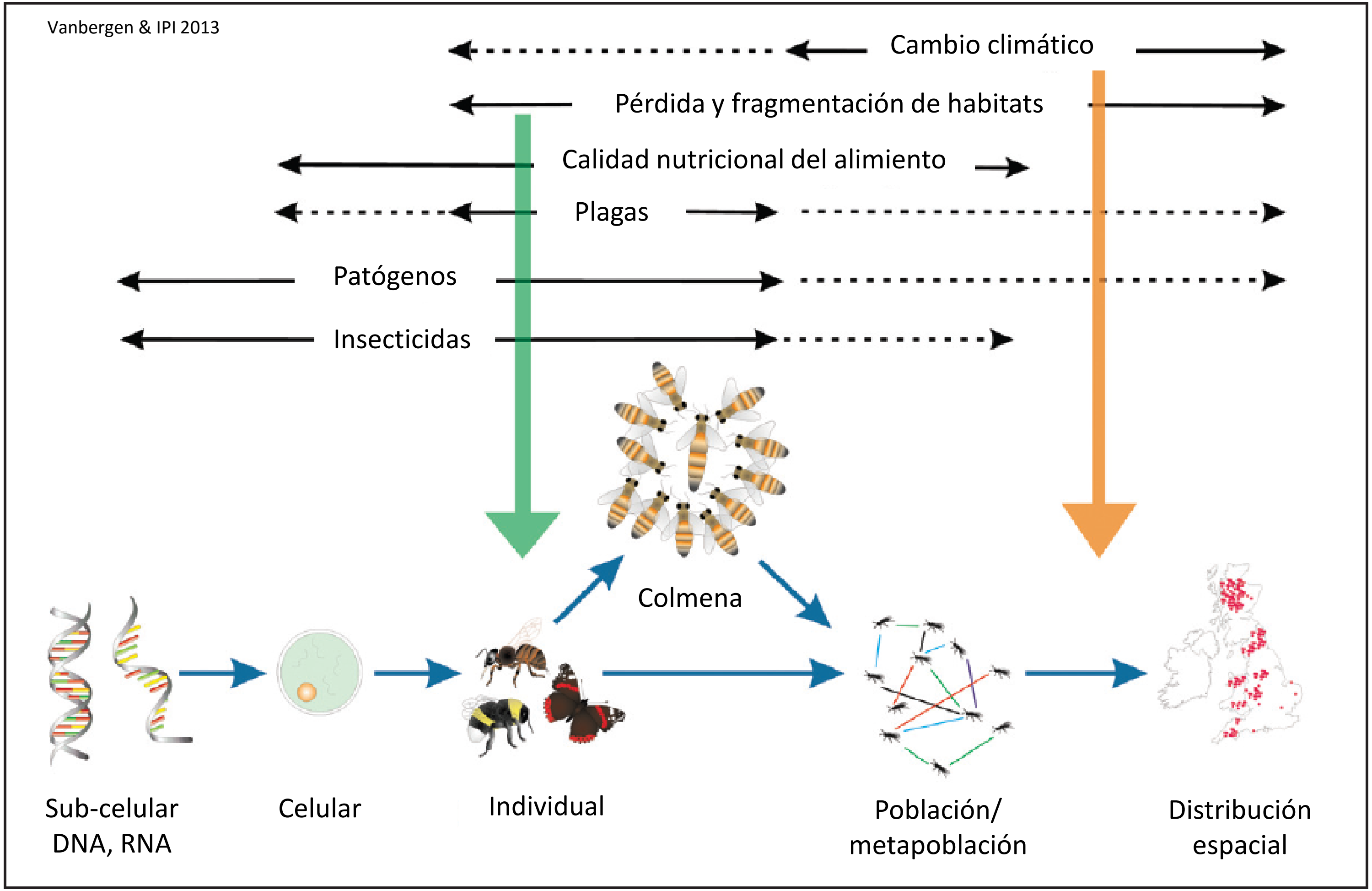


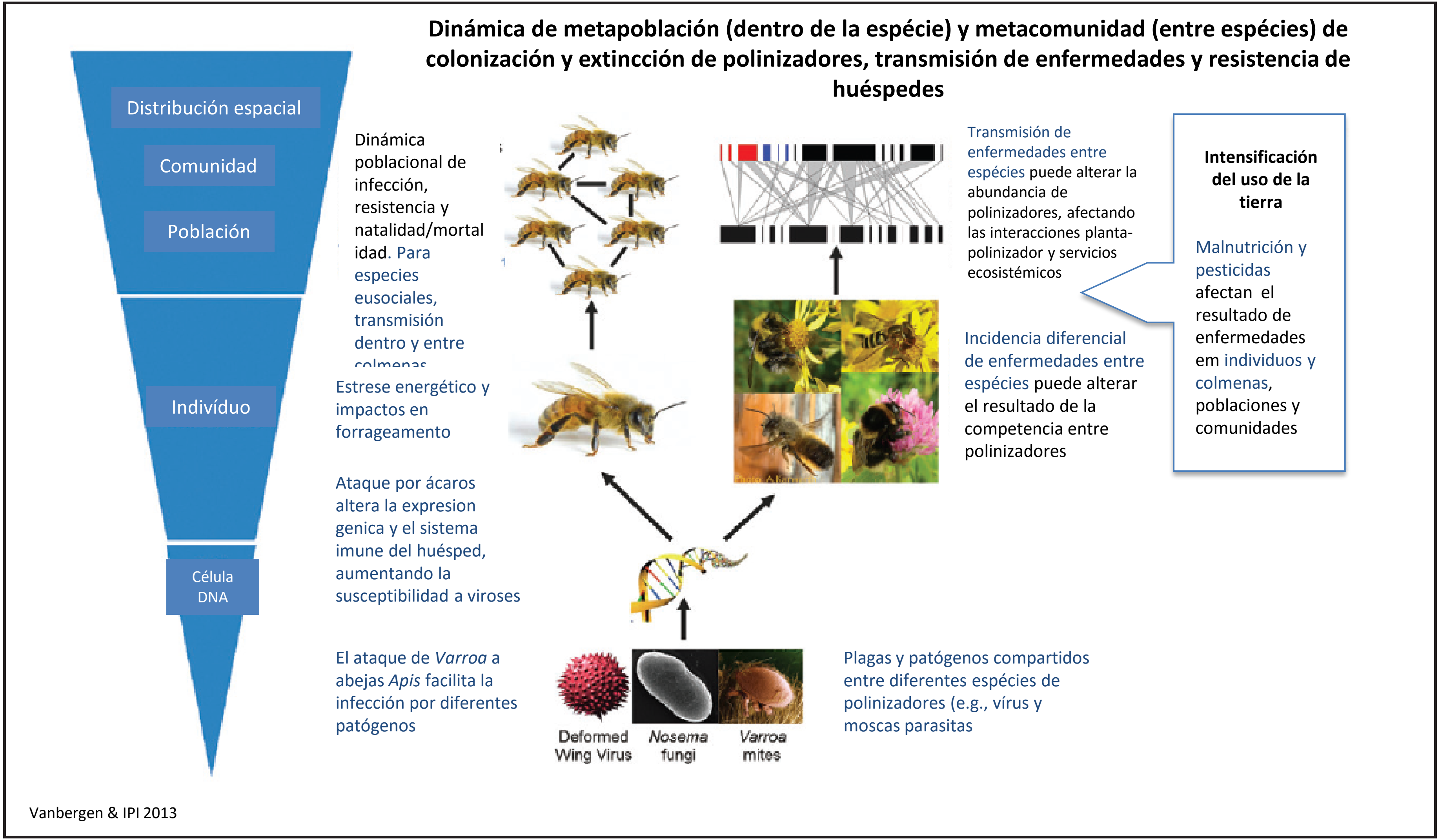
Bialowieza, Polonia

Albrecht et al. 2014

Sección 3: Amenazas a los polinizadores

Multiplos factores en sinergia

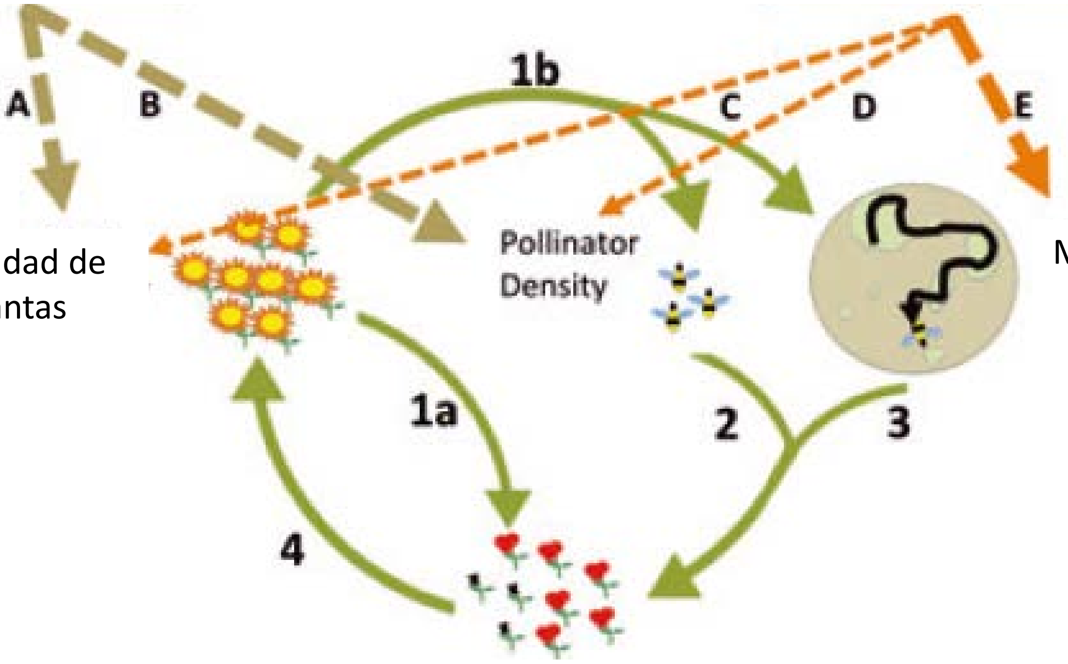



Dinámica de metapoblación (dentro de la espécie) y metacomunidad (entre espécies) de colonización y extincción de polinizadores, transmisión de enfermedades y resistencia de huéspedes
Distribución espacial
Comunidad
Población
Indivíduo
Célula DNA
Dinámica poblacional de infección, resistencia y natalidad/mortalidad. Para especies eusociales, transmisión dentro y entre colmenas
Transmisión de enfermedades entre espécies puede alterar la abundancia de polinizadores, afectando las interacciones planta-polinizador y servicios ecosistémicos
Intensificación del uso de la tierra
Malnutrición y pesticidas afectan el resultado de enfermedades em individuos y colmenas, poblaciones y comunidades
Estrese energético y impactos en forrageamento
Incidencia diferencial de enfermedades entre espécies puede alterar el resultado de la competencia entre polinizadores
Ataque por ácaros altera la expresion genica y el sistema imune del huésped, aumentando la susceptibilidad a viroses
El ataque de Varroa a abejas Apis facilita la infección por diferentes patógenos
Deformed Wing Virus
Nosema fungi
Varroa mites
Plagas y patógenos compartidos entre diferentes espécies de polinizadores (e.g., vírus y moscas parasitas
Vanbergen & IPI 2013

Fragmentación de habitats y aislamiento

Pérdida de hábitats

Fragmentacíon de hábitats

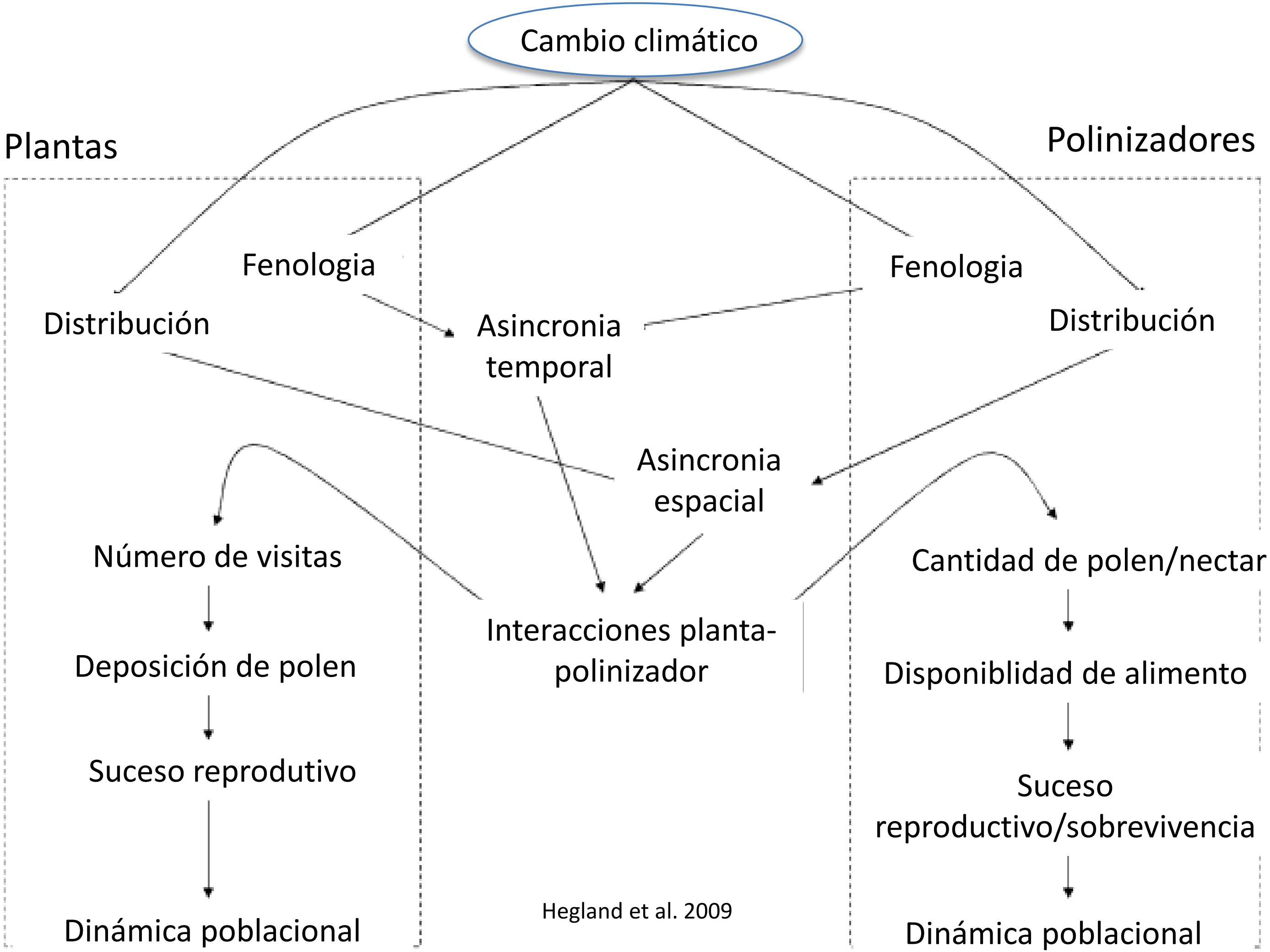


Densidad de plantas

Movimiento de polinizadores

Suceso de polinización

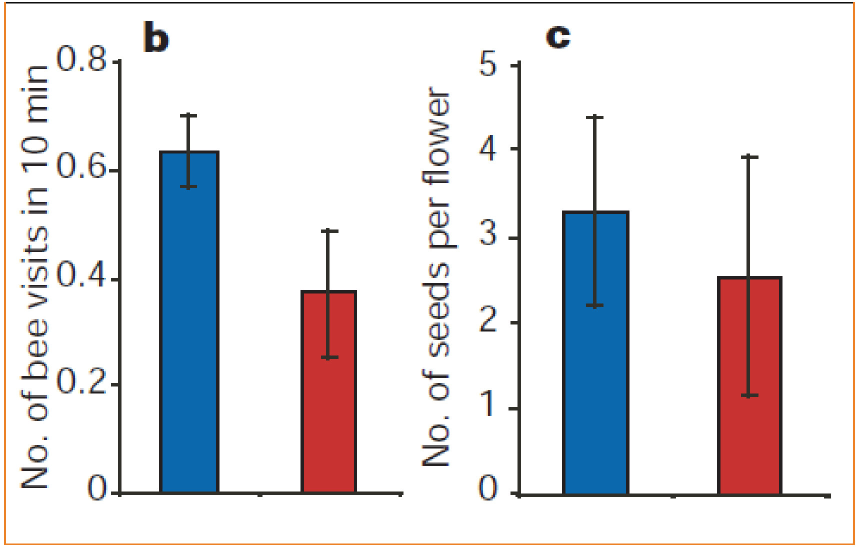
Hadley & Betts 2011



Hegland et al. 2009

Introducción de especies exoticas

Impatiens glandulifera



Stachys palustris

Impatiens glandulifera

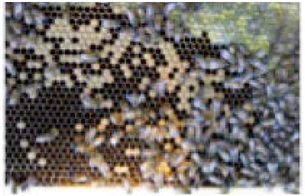
L. Chittka, S. Schürkens 2001

Pesticidas

Muerte aguda

Efectos crónicos

-Función inmune debilitada;
-Reproducción debilitada;
-Baja sobrevivencia de reinas.

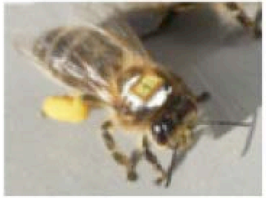


Efectos en habitat

-Monoculturas em áreas agrícolas;
-Uso de herbicidas reduce el forrageamento al lado de carreteras y campos;
-Manejo de plantas dañinas invasoras com herbicidas reduce la disponibilidad de alimento.

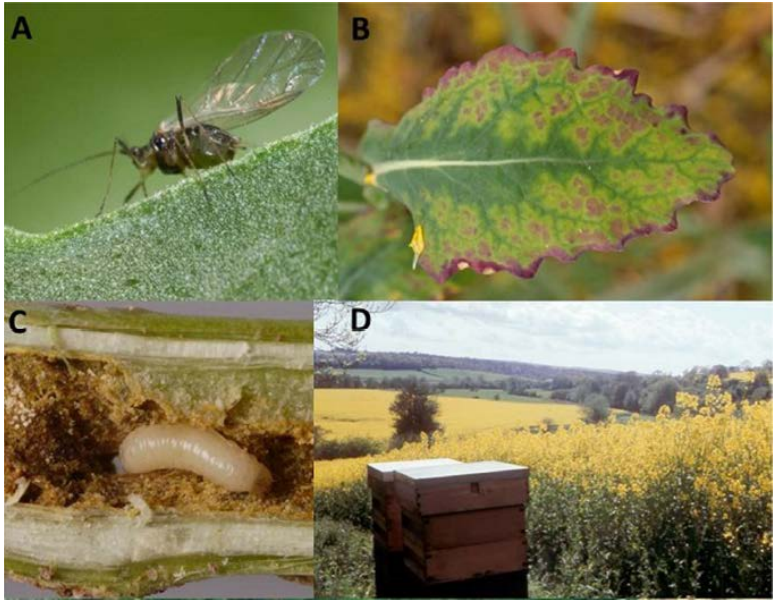
Otros efectos

-Navegación debilitada.

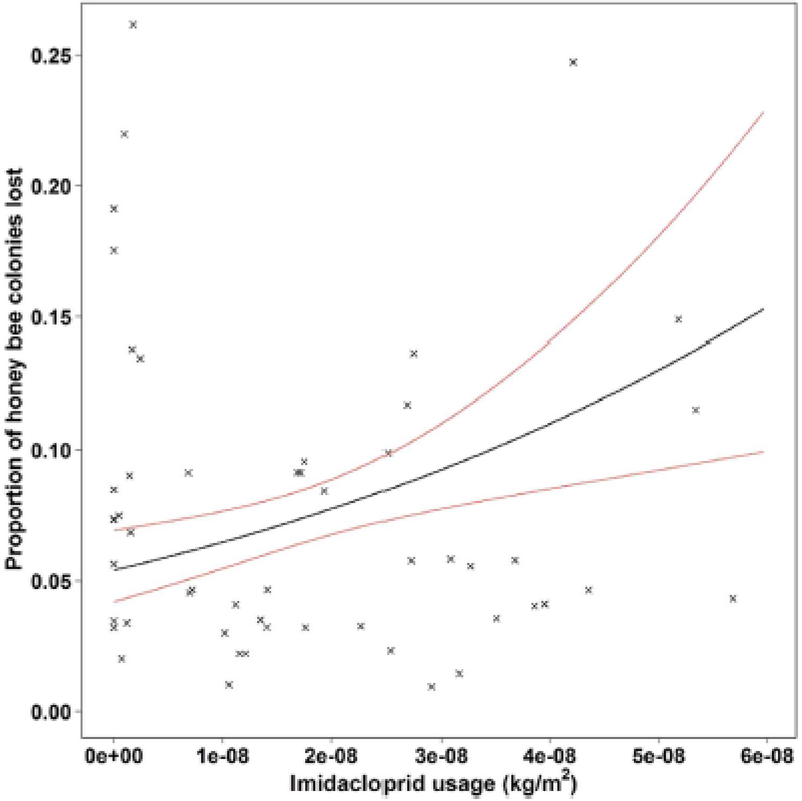


http://pollinatorstewardship.org/?p=1

Pesticidas



Canola en Gran
Bretanha

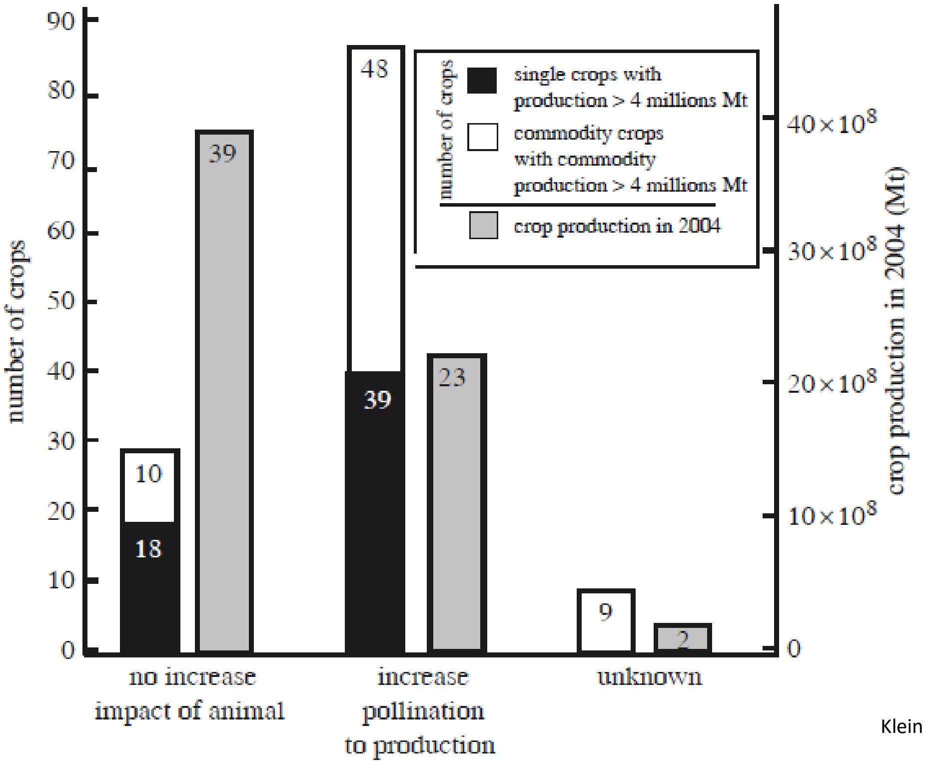


Budge et al. 2015

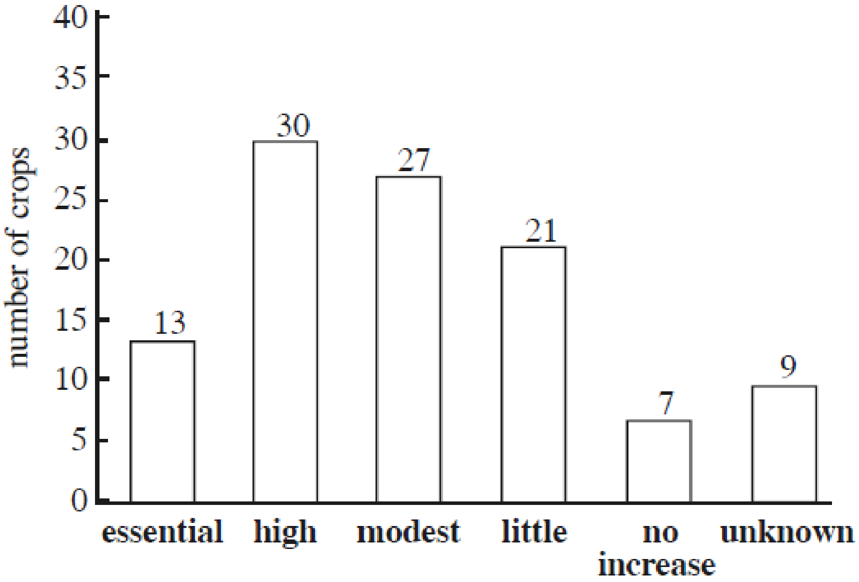
Sección 4: Impactos de la pérdida de polinizadores

Dependencia de la agricultura en los polinizadores

Importancia de los polinizadores para cultivos



Ni vel de dependencia



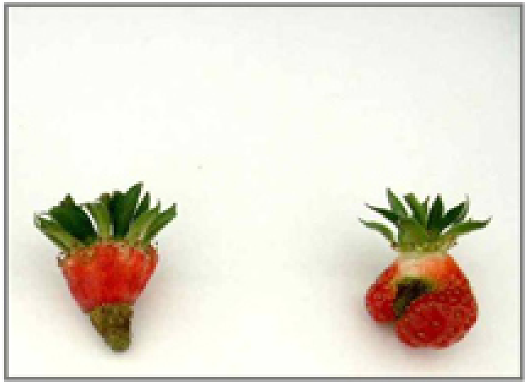
Klein et al. 2007

Aumento de cantidad, tamaño y calidad

Polinización cruzada por insectos

Autopolinización y viento

vs.

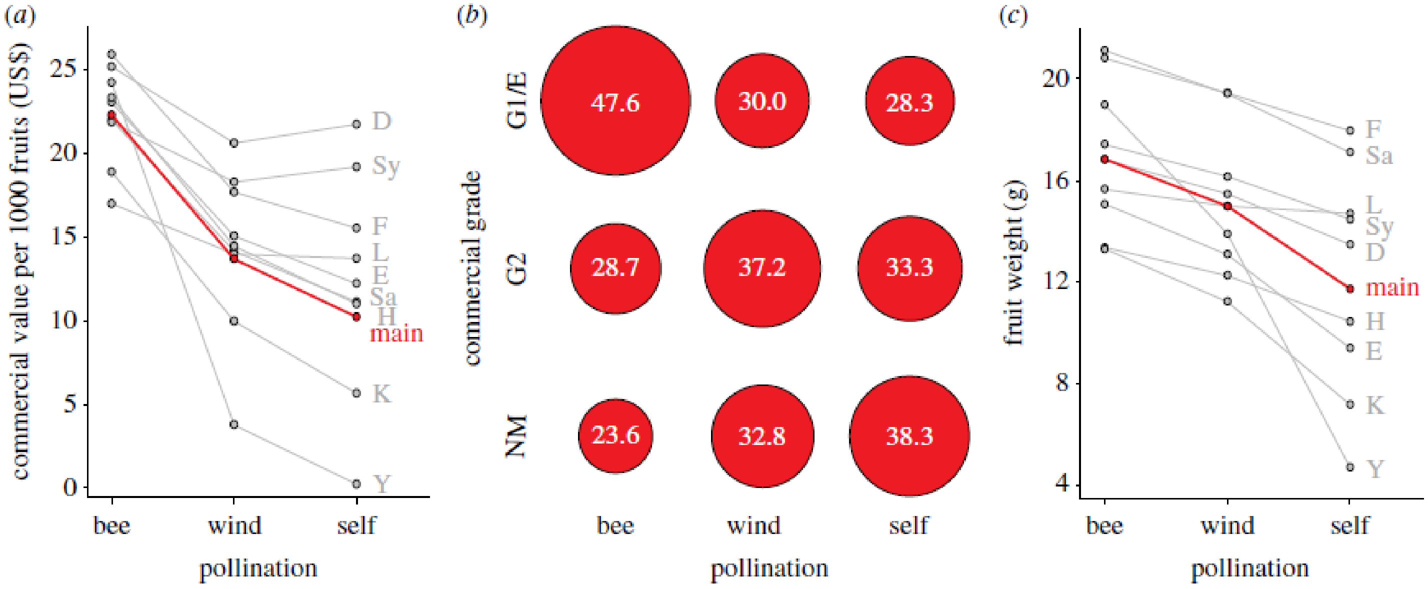


http://blog.nature.org/science/2013/04/23/wild-pollinators-are-critical-in-keeping-our-picnic-baskets-full/

Aumento en el valor comercial de 38.6%, comparado a la polinización por viento y de 54.3%, comparado a auto-polinización.

1.5 milliones de toneladas de fresa vendidas en Europa en 2009 = US$ 1.12 mil milliones (€0.82 mil milliones).

Aumento de cantidad, tamaño y calidad

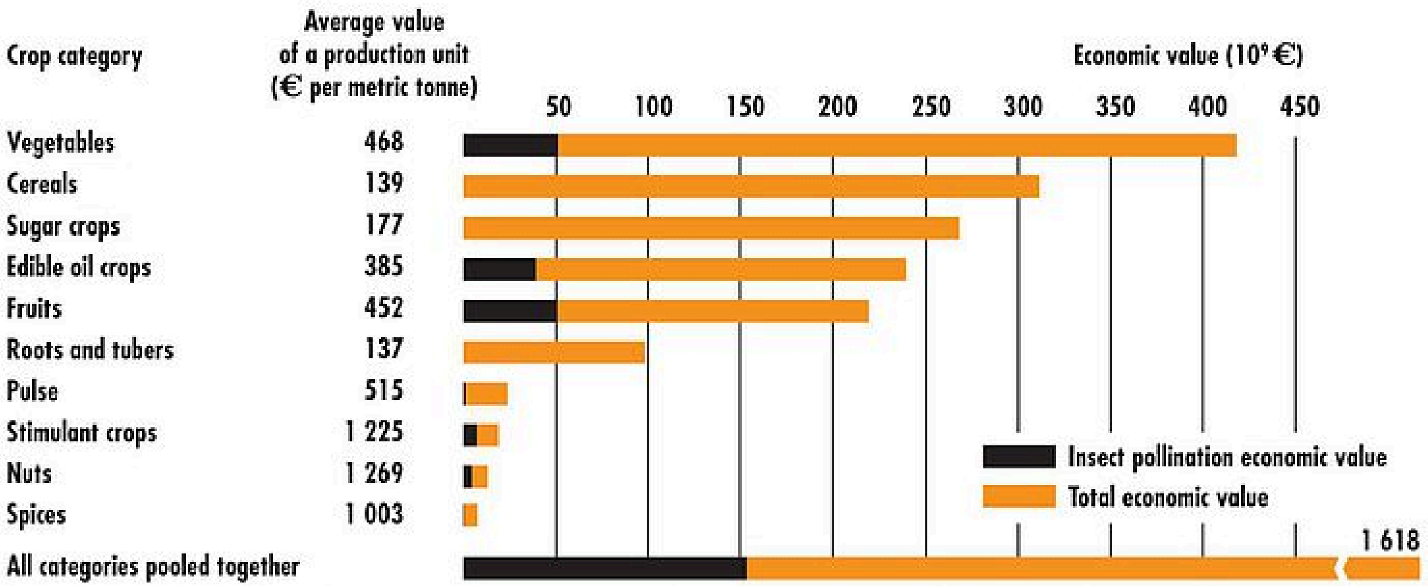


Producción de hormonios reguladores de crecimiento mediada por polinizadores

Klatt et al. 2013

Valor económico de la polinización

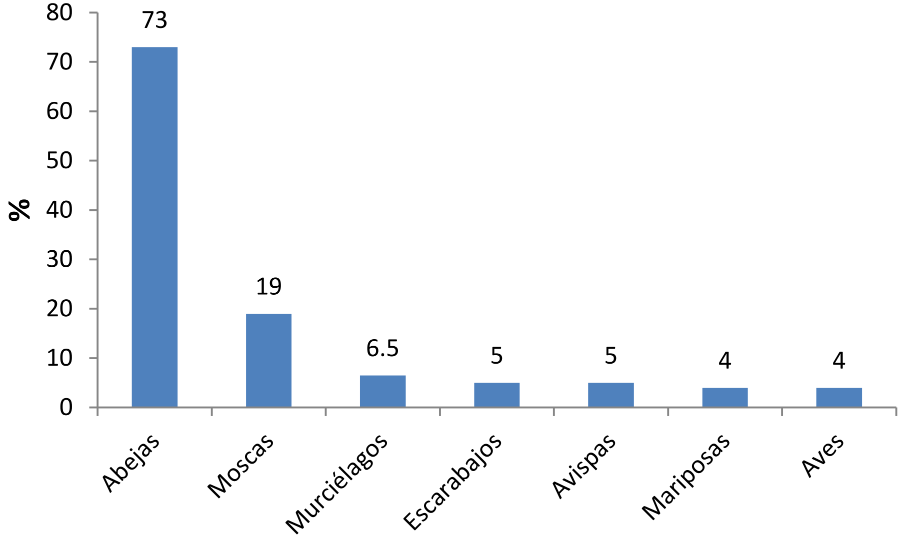
Impacto de la polinización por insectos en la producción agrícola



153 mil milliones de euros

[6] Gallai N. et al., 2009. "Economic valuation of the vulnerability of world agriculture confronted with pollinator decline". Ecological Economics, 68: 810-821

Polinización de los cultivos mundiales



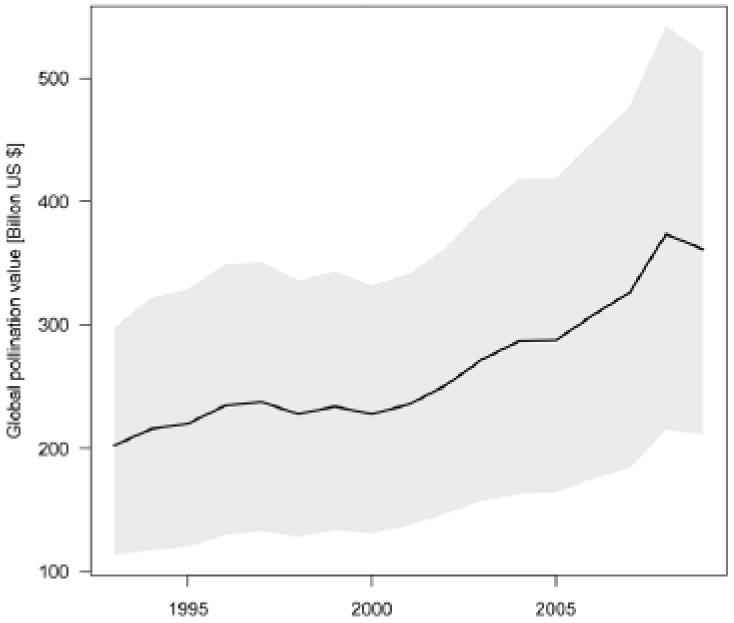


Figure 1. Temporal trend of global pollination benefit. Displayed are the values based on the average pollination dependency of crops (bold line) as well as on the upper and lower range of the values given by [15]. Values are in billion US $ inflation corrected for the year 2009.
doi:10.1371/journal.pone.0035954.g001

Lautenbach et al. 2012

Valor económico de la polinización

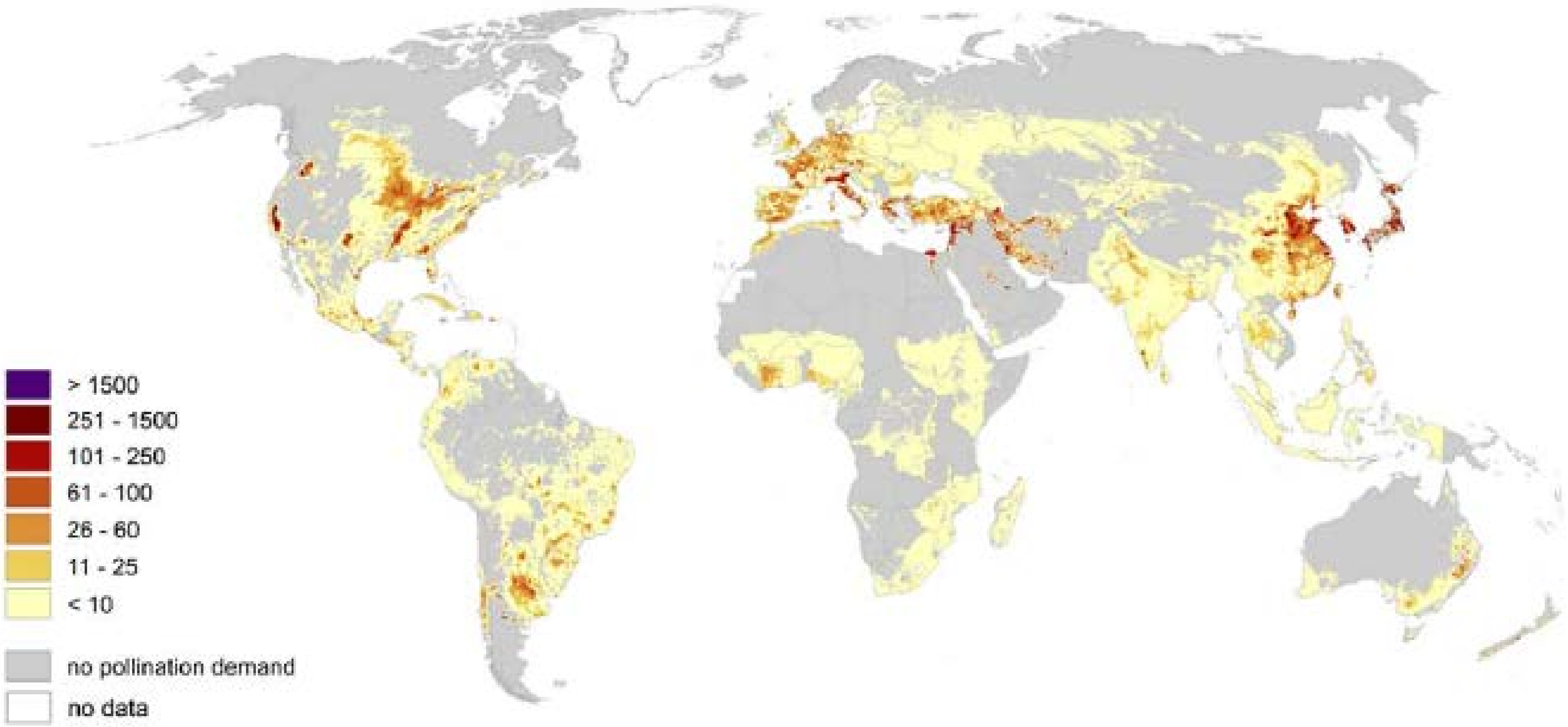
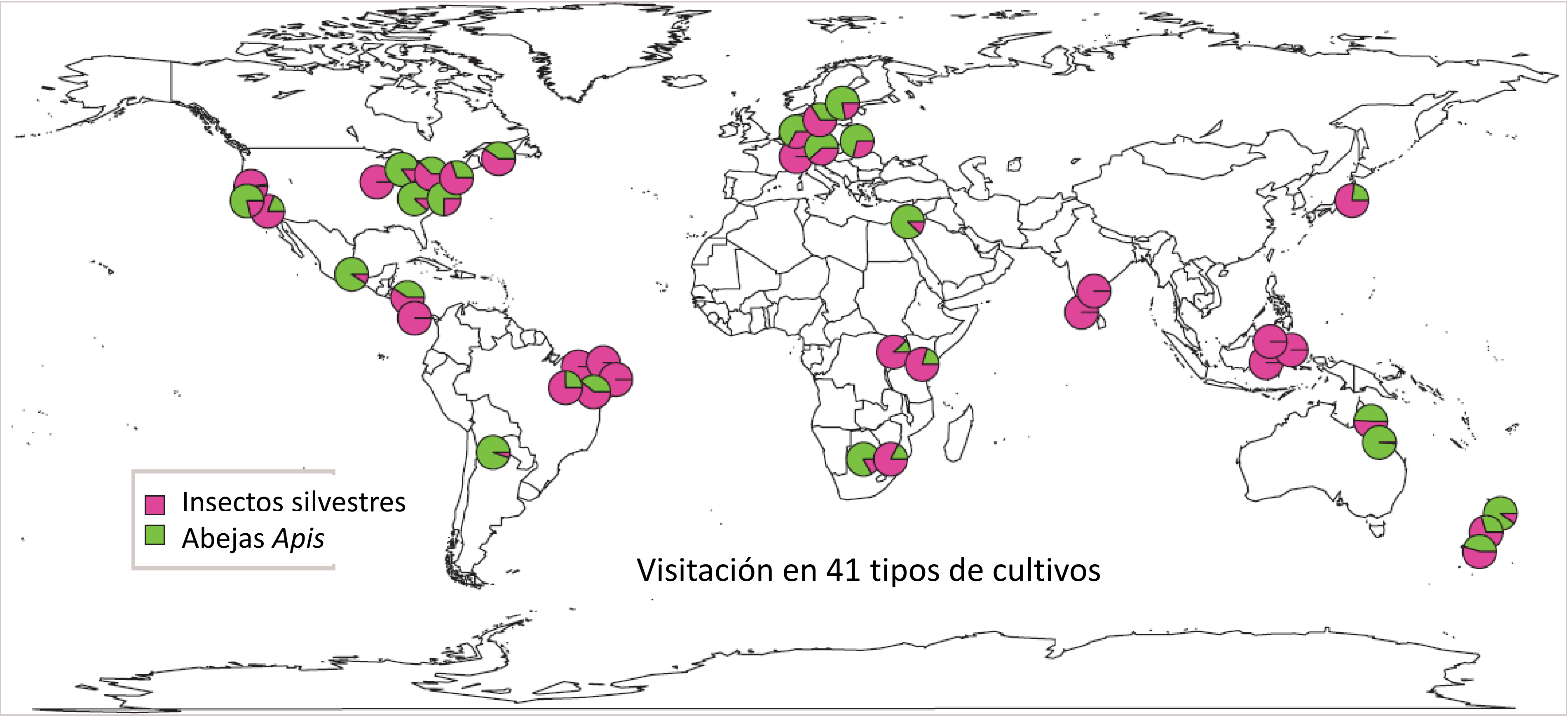


Figure 8. Global map of pollination benefits. Values are given as US $ per hectare for the year 2000. The values have been corrected for inflation (to the year 2009) as well as for purchasing power parities. The area we relate yields to is the total area of the raster cell.
doi:10.1371/journal.pone.0035954.g008

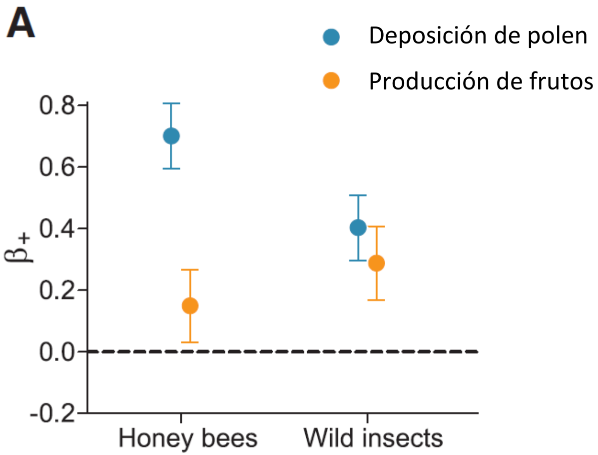
Lautenbach et al. 2012

Polinizadores silvestres y manejados

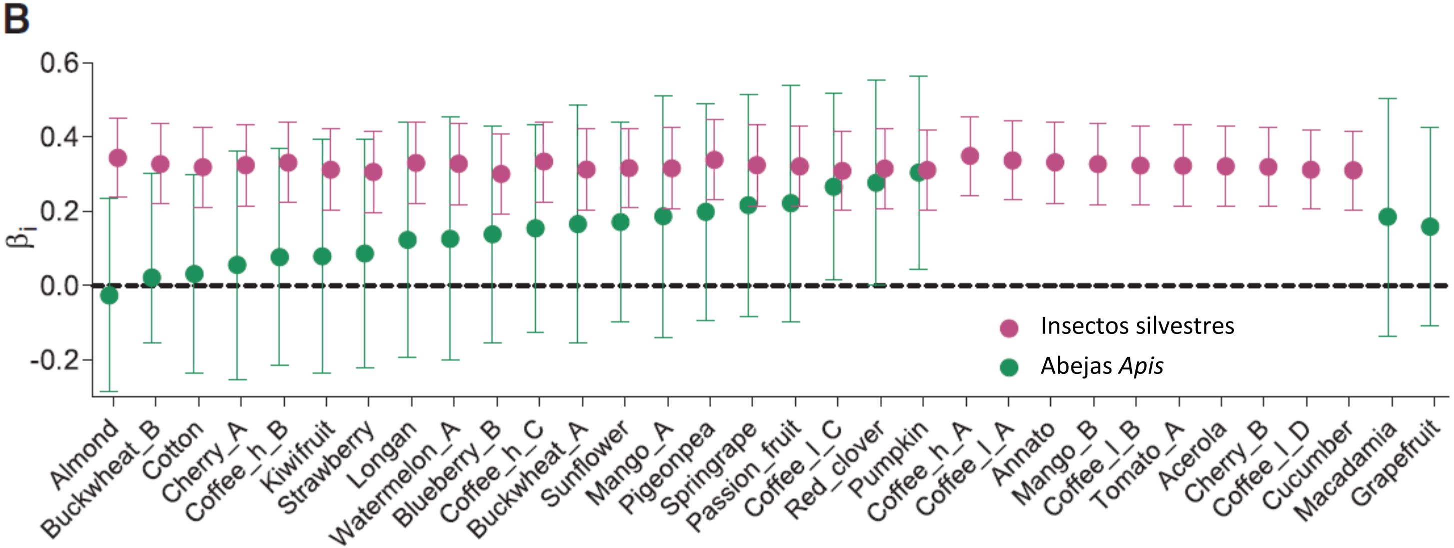


Garibaldi et al. 2013

Polinizadores silvestres y manejados



Visitación y producción de frutos



Garibaldi et al. 2013

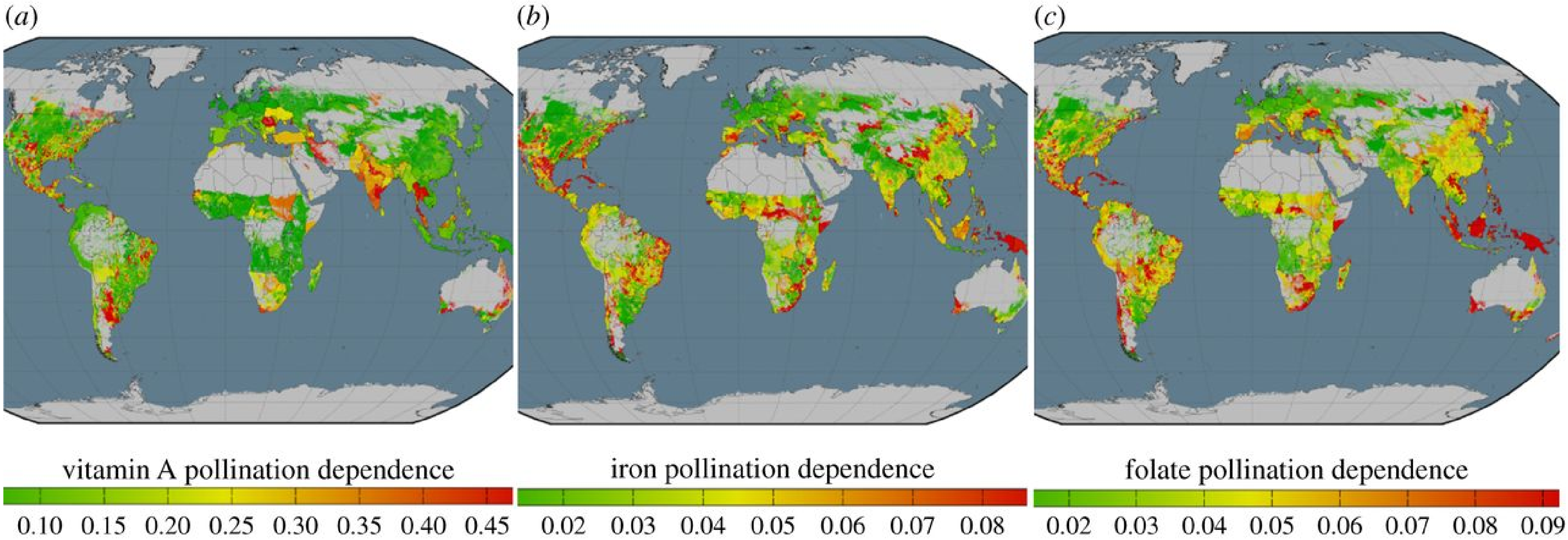
Efectos en la salud

PROCEEDINGS OF THE ROYAL SOCIETY B

rspb.royalsocietypublishing.org

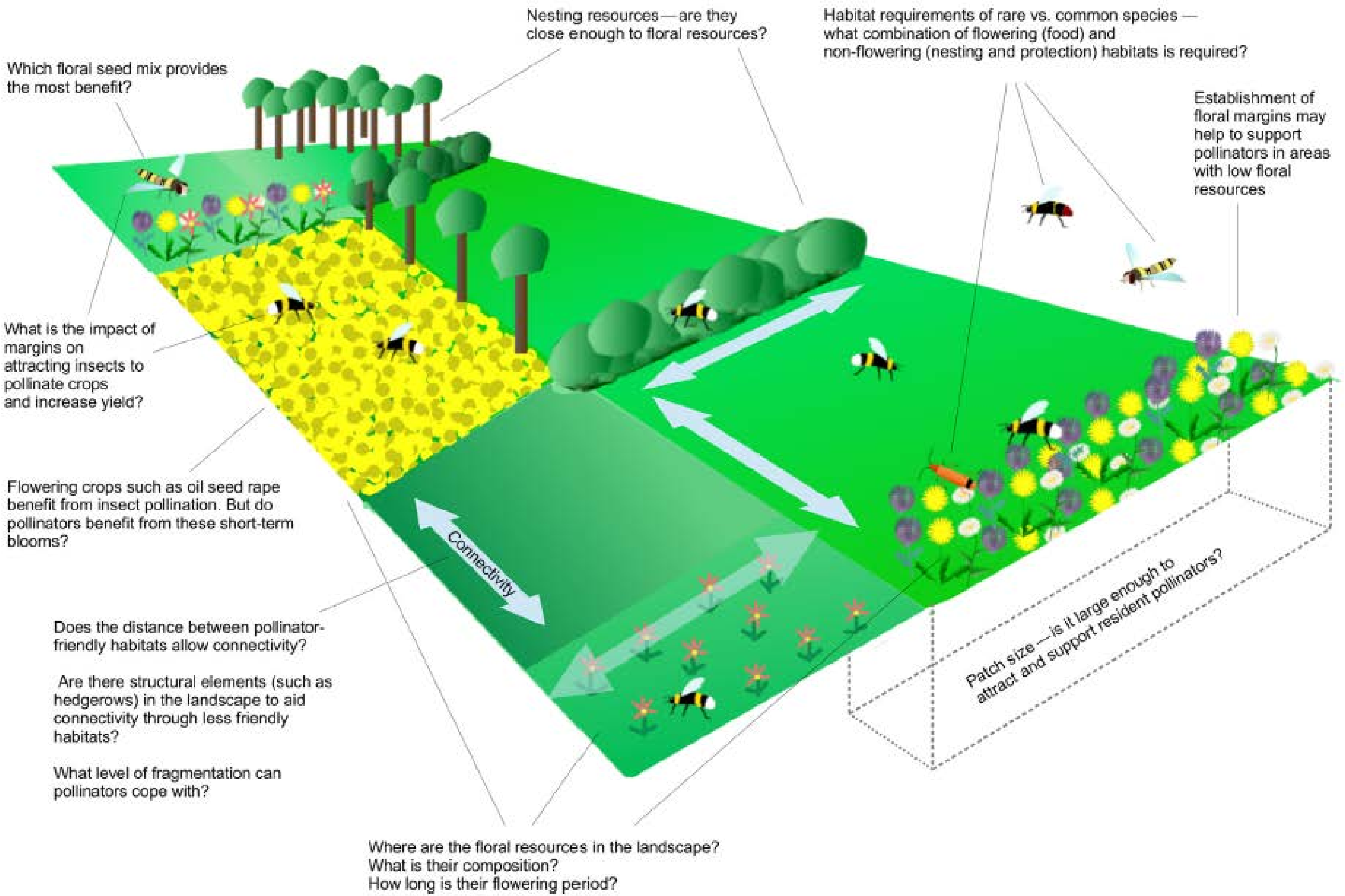
Global malnutrition overlaps with pollinator-dependent micronutrient production

Rebecca Chaplin-Kramer[1], Emily Dombeck[2], James Gerber[2], Katherine A. Knuth[2], Nathaniel D. Mueller[2], Megan Mueller[3], Guy Ziv[1,4] and Alexandra-Maria Klein[5]



Sección 5: Estrategias de mitigación

Manejo de paisaje



Gill et al. 2016

Manejo de paisaje

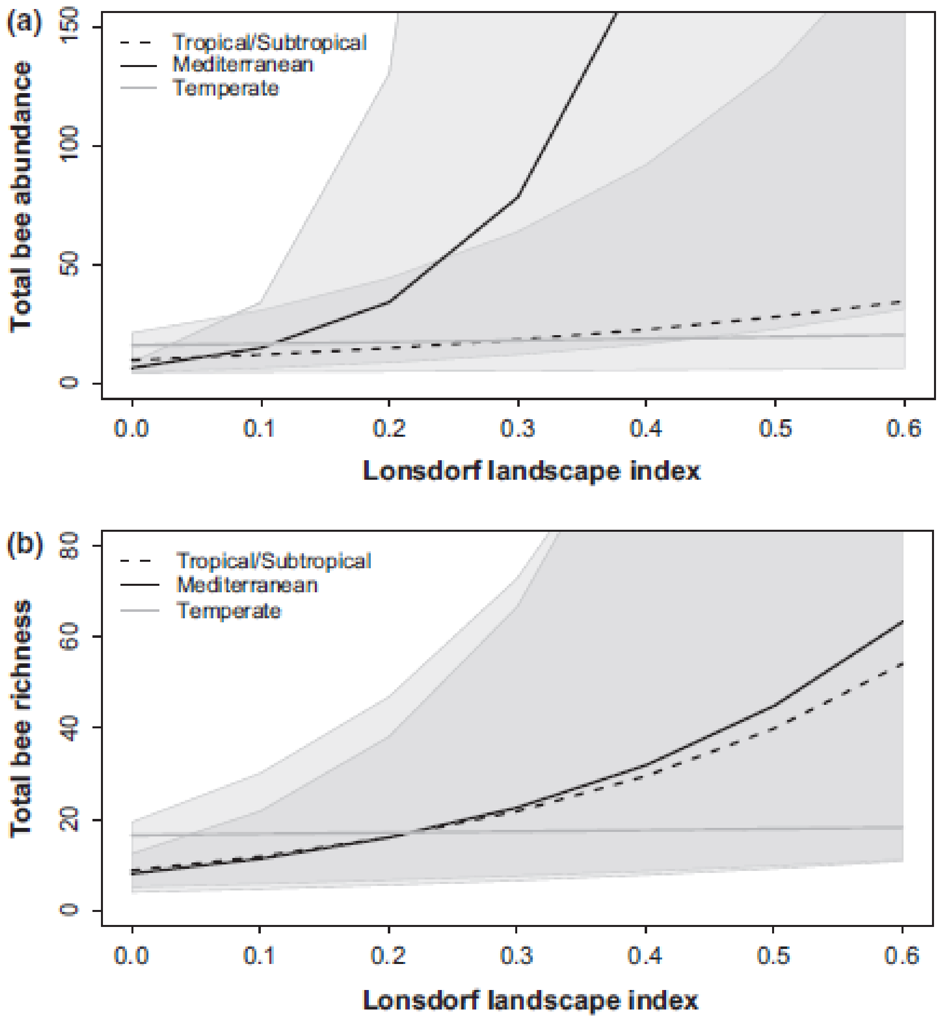
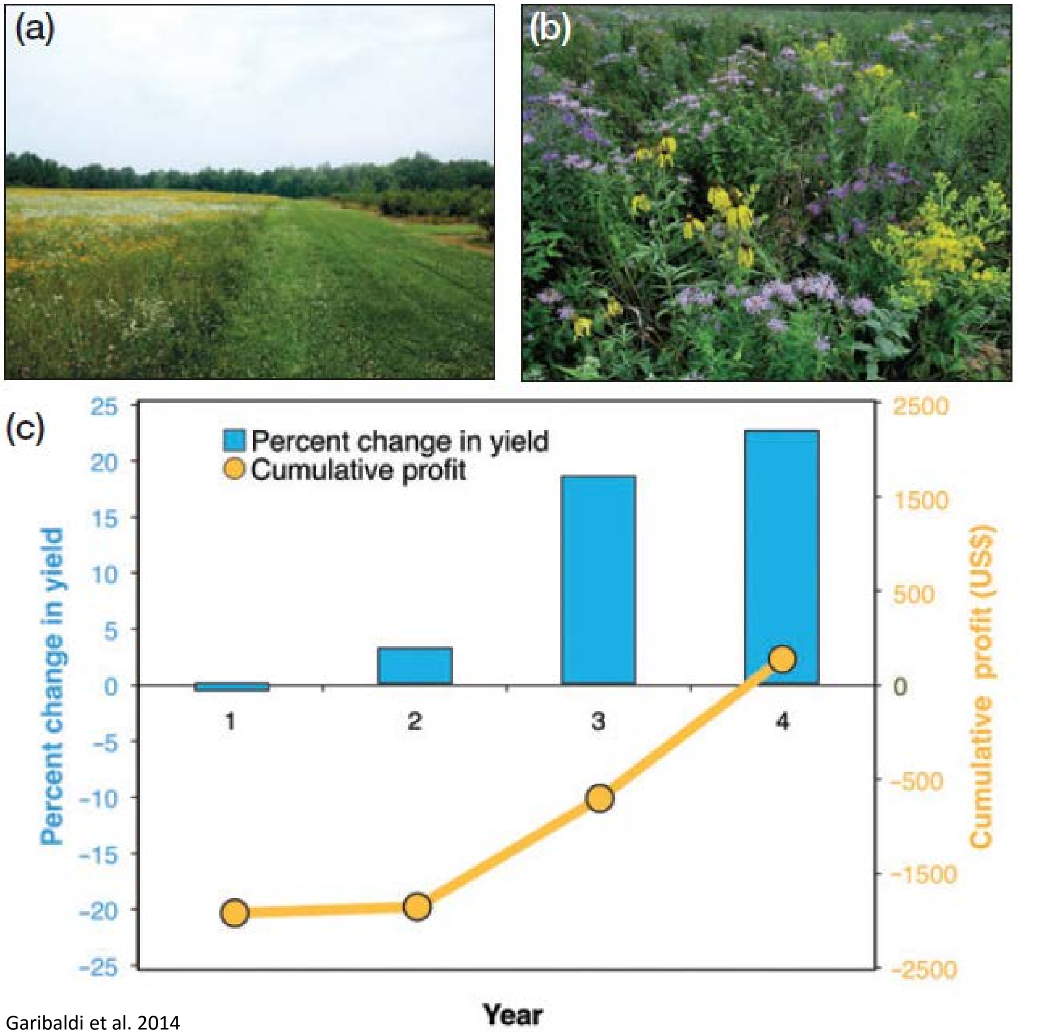


Figure 2 Response to Lonsdorf landscape index (LLI) of wild bee abundance (a) and richness (b) by biome, based on model-averaged partial regression coefficients and unconditional 90% CIs (in Table 3) for tropical and subtropical studies (dashed line for mean) and Mediterranean studies (black line for mean) (grey shading for CIs with dark grey denoting overlapping CIs). Mean effect for temperate studies provided by grey line for reference (CIs not presented due to insignificance). LLI = 0.61 was maximum score observed for tropical landscapes, LLI = 0.19 for Mediterranean landscapes, and LLI = 0.40 for temperate landscapes.

Kennedy et al. 2013

Manejo de paisaje



Garibaldi et al. 2014

Figure 6. *Plantings of native wildflower species selected for support of pollinators enhance blueberry yield and profit in Michigan. (a) Planting in midsummer with blueberry on the right. (b) Close-up of a mature planting with a mix of flower forms, species, and colors, with blueberry in the background. (c) Percent change in blueberry yield (blue bars) between fields adjacent to wildflower plantings and fields without plantings. The gold line (cumulative profit) shows that the initial cost of establishment in the first year was paid for by the fourth year when higher yield resulted in a profit (Blaauw and Isaacs 2014).*

Sistemas agroecológicos

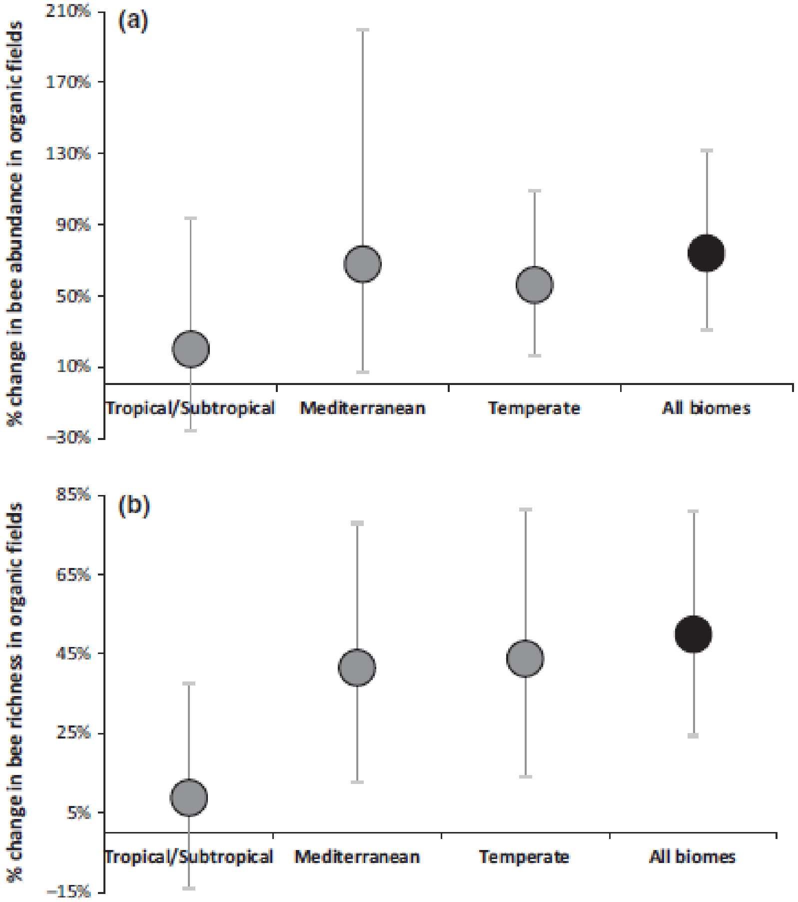


Figure 3 Percent change in wild bee abundance (a) and wild bee richness (b) in organic fields relative to conventional fields for tropical and subtropical studies (n = 10), Mediterranean studies (n = 8), temperate studies (n = 21) and overall (n = 39). Estimates based on model-averaged partial regression coefficients and unconditional 90% CIs by biome and CIs 95% overall (asymmetric CIs due to exponential relationship) (in Tables 2 and 3).

Kennedy et al. 2013

Políticas de protección en diferentes escalas

NACIONES
UNIDAS

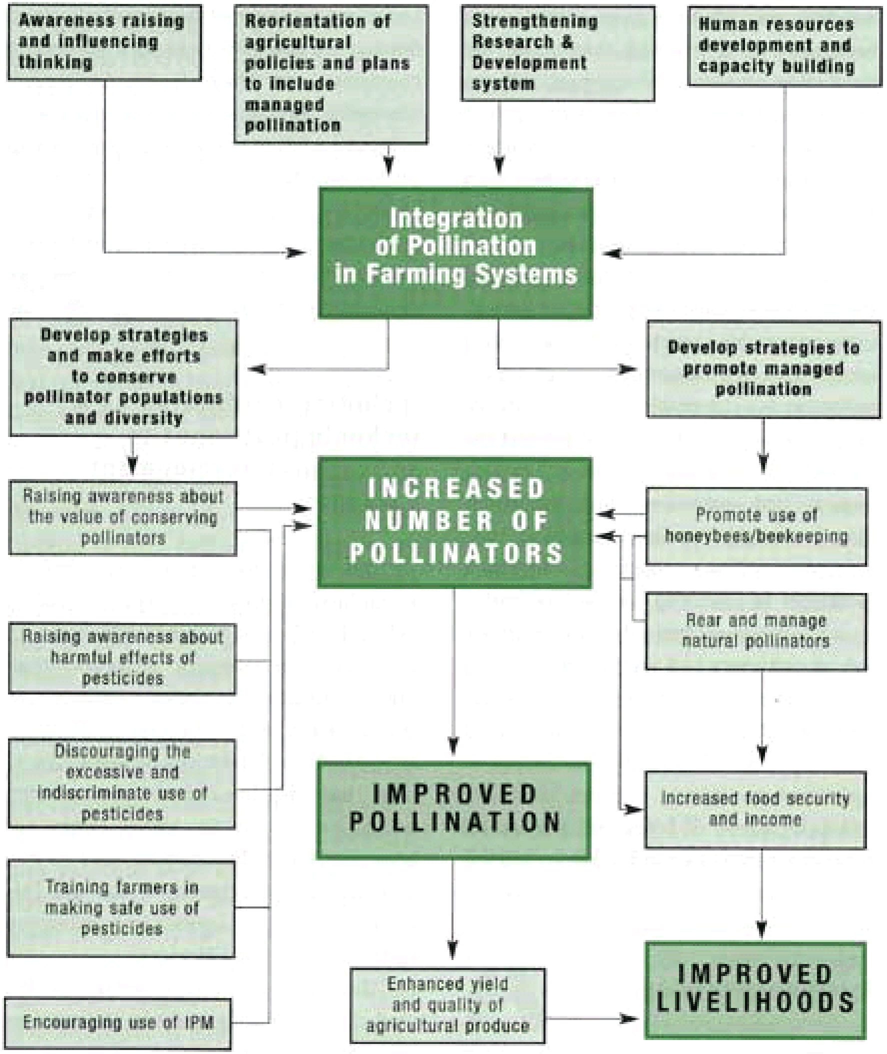
UNEP

Plataforma Intergubernamental
Científico-normativa sobre Diversidad
Biológica y Servicios de los Ecosistemas

Resumen del informe para los responsables de la formulación de políticas de la Plataforma Intergubernamental Científico-normativa sobre Diversidad Biológica y Servicios de los Ecosistemas sobre polinizadores, polinización y producción de alimentos

Plataforma Intergubernamental Científico-normativa sobre Diversidad Biológica y Servicios de los Ecosistemas

(producto previsto 3 a) del programa de trabajo para 2014-2018)



Awareness raising and influencing thinking
Reorientation of agricultural policies and plans to include managed pollination
Strengthening Research & Development system
Human resources development and capacity building
Integration of Pollination in Farming Systems
Develop strategies and make efforts to conserve pollinator populations and diversity
Develop strategies to promote managed pollination
Raising awareness about the value of conserving pollinators
INCREASED NUMBER OF POLLINATORS
Promote use of honeybees/beekeeping
Rear and manage natural pollinators
Raising awareness about harmful effects of pesticides
Discouraging the excessive and indiscriminate use of pesticides
IMPROVED POLLINATION
Increased food security and income
Training farmers in making safe use of pesticides
Encouraging use of IPM
Enhanced yield and quality of agricultural produce
IMPROVED LIVELIHOODS

Sección 6: Como calcular el valor económico de los polinizadores

Por que calcular el valor de la polinización?

Hacendados

Tomadores de decisiones

Publico em general

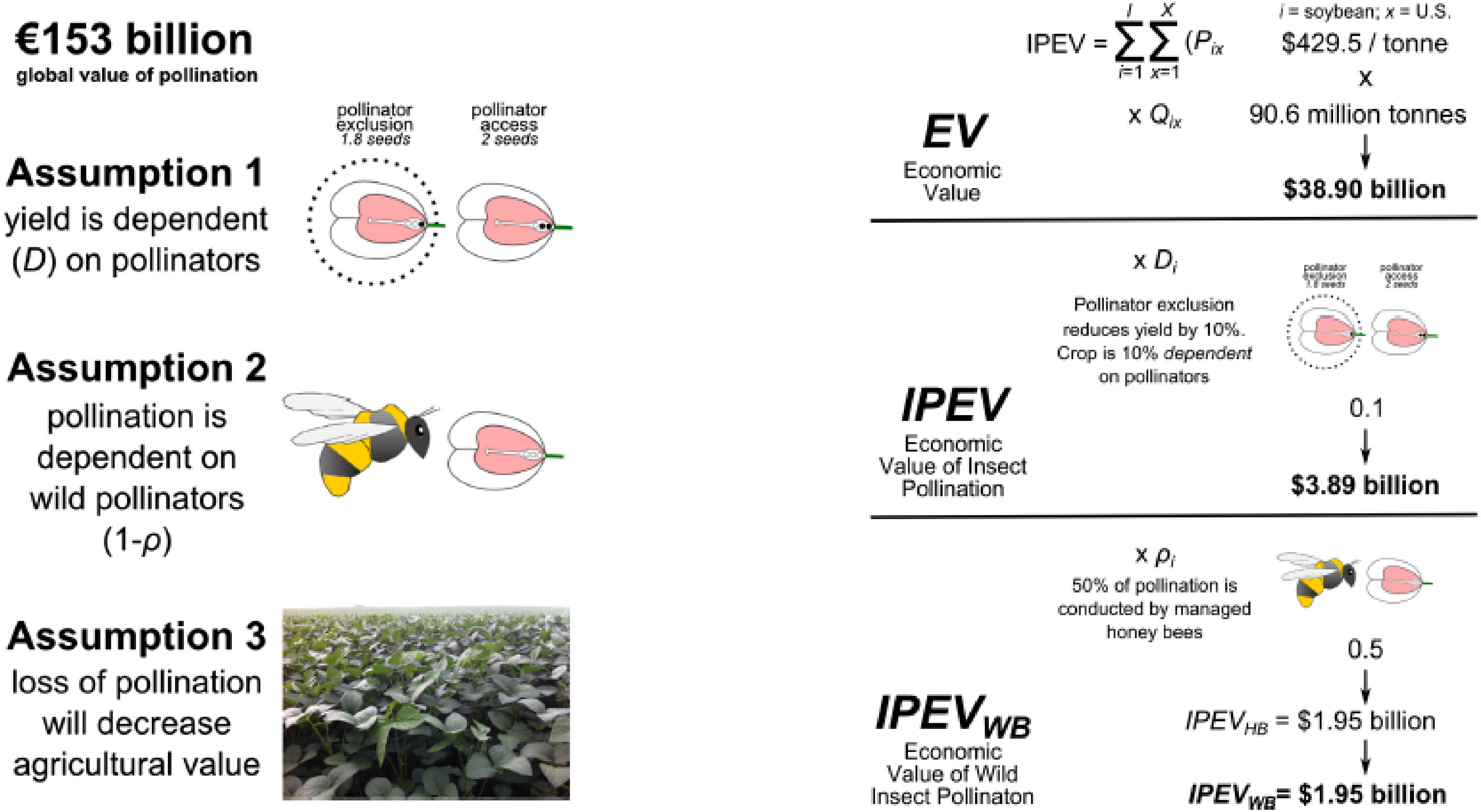
Motivación para proteger los habitats de los polinizadores

Pressión a los políticos

Implementación de programas agro-ambientales con foco en los polinizadores

Por extensión, conservación más generalizada

Premisas



Melathopoulos et al 2015

Métodos más comunes

Table 1
Valuations of pollination services.

Method valuing pollinator contribution to crop value	Date of first use	Calculation[a]	No. studies that differentiate between wild and managed pollinators (total no. studies in brackets)	References	Key limitation
Production value 1. Economic value (*EV*)	1943	*QP*	0 (6)	Butler (1943), Fluri and Frick (2005), Levin (1984), Martin (1973), Metcalf et al. (1962), Winston and Scott-Dupree (1984)	Dependency of all crops assumed to be 100%, no differentiation between pollination by wild versus managed species, assumed perfectly elastic demand and cost of other inputs not accounted for.
Production value 2. Total economic value of insect pollination (*IPEV*)	1989	*QPD* (ρ)	8 (12)	Ashworth et al. (2009), Calderone (2012), Chacoff et al. (2010), Gallai et al. (2009), Kasina et al. (2009a), Lautenbach et al. (2012), Losey and Vaughan (2006), Morse and Calderone (2000), O'Grady (1987), Robinson et al. (1989), Southwick and Southwick (1992), Winfree et al. (2011)	Dependency of all crops based on some empirical research, but frequently not extensive, frequently an arbitrary differentiation between pollination by wild versus managed species (but see Winfree et al., 2011), demand assumed perfectly elastic (with some exceptions (but see Gallai et al., 2009; Southwick and Southwick, 1992)) and cost of other inputs not accounted for (but see Winfree et al., 2011).
Replacement value	1995	Replacement of all pollination by labor or wild pollinators by managed bees.	2 (3)	Allsopp et al. (2008), Mouton (2011), Muth and Thurman (1995)	The costs of replacing pollination with human labor have been shown to exceed total production value for the crop and, hence, not a suitable substitute (Allsopp et al., 2008). The shortfall in published managed bee stocking rates is limited to crops where managed pollinators are used and data is reliably collected.
Contingent valuation method	2010	Willingness to pay for wild pollinator protection	1 (1)	Mwebaze et al. (2010)	Evidence suggests that contingent valuation methods do not correspond to the actual amounts spent on conservation (Pearce, 2007; Vatn and Bromley, 1994).
Landscape service flows	2004	Relate landscape patterns to bee diversity and abundance and crop yields	4 (4)	Chaplin-Kramer et al. (2011), Morandin and Winston (2006), Olschewski et al. (2006), Ricketts et al. (2004)	Empirically robust measure of actual flows but limited by previous approaches with regards to being integrated with agricultural economic approaches.

[a] Q = quantity of crop grown, P = crop price, D = dependence of crop on animal-mediated pollination (see text).

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Limitaciones

95% = mean value of pollination-driven yield reduction lies between 100% and 90% in experiments comparing commercial yields with and without animal pollinators. Pollination is reported as "essential".

65% = pollination-driven yield reduction ranges between 40 - <90%. Pollination is reported as "great".

25% = pollination-driven yield reduction ranges between 10 and <40%. Pollination is reported as "modest".

5% = pollination-driven yield reduction ranges between >0 and<10% reduction. Pollination is reported as "little".

Uncertainty surrounding the calculation for dependency using figures from Klein et al. (2007) for the 10 highest valued pollination services in the most recent global valuation of pollination services by Gallai et al. (2009).

Crop	Value of Pollination (€ billions)	No. studies demonstrating dependency[1]	No. studies included that do not directly measure dependency[1]	Total[2]	Total no. cultivars represented[3]	Total no. fields represented[3]	No. countries studies involve
Apple	15.72	1	7	11	1	1	1
Cucumbers and gherkins	15.35	0	1	1	–	–	–
Watermelons	14.48	2	0	7	1[4]	1	1
Soybean	10.88	2	1	6	4	3	2
Cottonseed	10.05	0	1	1	–	–	–
Guavas, mangoes, and mangosteens	9.05	0	1	3	–	–	–
Coconuts (incl. Copra)	6.67	1	1	2	na	1	1
Other melons (incl. cantaloupes)	6.23	0	1	2	–	–	–
Pears and quinces	6.01	1	2	3	2	2	1
Peaches	5.00	1	0	1	1	1	1

Limitaciones


nature COMMUNICATIONS

ARTICLE

Received 14 Nov 2014 | Accepted 7 May 2015 | Published 16 Jun 2015 DOI: 10.1038/ncomms8414 OPEN

Delivery of crop pollination services is an insufficient argument for wild pollinator conservation

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